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Soviet Geography: Review and Translation

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This translation and publication project was undertaken by the American Geographical Society in the conviction that the dissemination of the fruits of Soviet geographic research would be a service to American geographers and would help bring about professional contacts between geographers of the two countries. The National Science Foundation encouraged the project and is supporting it by a grant.

Readers are invited to send in their comments and discussion of articles published in *Soviet Geography*. Readers are also encouraged to submit suggestions as to published Soviet geographic literature worthy of translation. Such suggestions should relate to articles of general substantive or methodological interest rather than materials of narrow, specialized appeal.

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TRANSLITERATION TABLE

Russian			English	Russian			English
А	а	*а*	a	Р	р	*р*	r
Б	б	*б*	b	С	с	*с*	s
В	в	*в*	v	Т	т	*т*	t
Г	г	*г*	g	У	у	*у*	u
Д	д	*д*	d	Ф	ф	*ф*	f
Е	е	*е*	e*	Х	х	*х*	kh
Ж	ж	*ж*	zh	Ц	ц	*ц*	ts
З	з	*з*	z	Ч	ч	*ч*	ch
И	и	*и*	i	Ш	ш	*ш*	sh
Й	й	*й*	y	Щ	щ	*щ*	shch
К	к	*к*	k	Ъ	ъ	*ъ*	"
Л	л	*л*	l	Ы	ы	*ы*	y
М	м	*м*	m	Ь	ь	*ь*	'
Н	н	*н*	n	Э	э	*э*	e
О	о	*о*	o	Ю	ю	*ю*	yu
П	п	*п*	p	Я	я	*я*	ya

(*) Instead of e, use ye at the beginning of names, after vowels and after the soft sign (').

The transliteration table is supplied for the general information of readers and to enable them to identify the geographic names on maps that will be reproduced from time to time in SOVIET GEOGRAPHY.

The transliteration system is the one proposed by the United States Board on Geographic Names. For more general use in textbooks and other popular needs, the following simplifications are recommended by the editor of SOVIET GEOGRAPHY:

1. Eliminate the use of (') and (").
2. Use i for iy, and y for yy.
3. Convert diphthongs ay, ey, oy, uy to ai, ei, oi, ui.

THE THIRD CONGRESS OF THE GEOGRAPHICAL SOCIETY OF THE USSR

(Following are translations of preprints prepared for the symposium on the role of geography in the study, utilization, conservation and renewal of the natural resources of the USSR. The preprints were made available through the courtesy of Aleksey P. Polezhayev, an exchange student from the Geography Faculty of Moscow University, who is spending the academic year 1959-60 at Columbia University)

THE ROLE OF GEOGRAPHERS IN THE STUDY, MAPPING, ECONOMIC APPRAISAL, UTILIZATION, CONSERVATION AND RENEWAL OF THE NATURAL RESOURCES OF THE USSR

By D. L. Armand, I.P. Gerasimov, K.A. Salishchev, Yu. G. Saushkin

The natural resources of a country or of one of its regions are its principal source of natural wealth. All sectors of the economy exist and develop by using up raw materials and energy from that reservoir.

There are three types of natural resources: inexhaustible, exhaustible and nonrenewable, exhaustible and renewable.

The first type of natural resources (inexhaustible) consists mainly of sources of energy and matter found outside of the earth's surface and its interior. They include solar radiation, atmospheric water, the energy of the wind, of the tides and so forth. In utilizing these resources, man does not need to be concerned about ultimate exhaustion, although it should be noted that these resources are not uniformly distributed in various geographic regions and may even be inadequate in some regions for intensive economic utilization.

The second type of natural resources (exhaustible and nonrenewable) includes mineral resources (raw materials and fuels), which required millenia for nature to create. Man utilizes mineral raw materials and fuels in the full knowledge that they cannot be restored.

The problem therefore is to achieve the most economical and technically perfected utilization of such resources. There is no doubt, however, that by the time known types of raw materials and fuels become exhausted man's technology will have developed ways of replacing them with other types not now in use.

The third type of resources (exhaustible and renewable), if rationally utilized, can be renewed as they are consumed so that their total reserves will not only not diminish, but will even increase. This type includes all biological resources: forest, fodder resources and other vegetable raw materials, commercial marine and land animals, soil fertility. These resources, of course, do not renew themselves. Renewal requires man to o maintain certain conditions and methods of utilization, to set himself consciously the goal of resource renewal and to make the necessary expenditures of labor and money.

It should be stressed that climatic and water resources also require careful management. Although they are inherently inexhaustible, it is up to man to keep them in "working" condition. For example, a polluted atmosphere reduces the possibility of using climatic resources (radiation and precipitation). Pollution can make water resources unsuitable for fish life and water supply. Water resources can be disorganized if the hydrological cycle is disturbed or if they are improperly redistributed in space.

The problem of studying, mobilizing and reproducing natural resources in accordance with a constantly rising demand is one of the basic problems facing the economics of a planned Socialist system. History will judge each generation by its success in leaving for its descendants richer and higher-quality reserves of natural resources than the ones existing earlier. From an economic point of view the problem can be formulated as the need for expanded reproduction of renewable natural resources constituting the subject and the means of production. At the same time the problem is to insure healthy living and working conditions for the population and to preserve great scientific and esthetic monuments created by nature.

As long as industry is still in its infancy and the land is utilized only to a small degree, natural resources appear to be inexhaustible. They are utilized without due regard for reduction of reserves or deterioration of quality. Under primitive or pioneering conditions, nature itself has the strength (without man's help) to renew many kinds of resources utilized by man. But as the productive forces grow, man's interference becomes deeper, more diversified and areally more widespread. The age-old natural order of things is disturbed and nature, to use an expression of Engels, begins to seek "revenge". In many cases the exhausted natural resources are replaced by overgrown or waterlogged forest clearings, wind-blown sand, gullies or silting river channels. That kind of management brings to mind the man who is sawing off the branch on which he is sitting, and the prospects of losing all they have built up become increasingly real to the reckless resource managers.

The objective of a planned state is to mobilize scientific thought and to construct a system of economic planning so as to insure a rational relationship and interaction between nature, on the one hand, and the growing productive forces, on the other.

Unfortunately, the seriousness of the problem of rational utilization, conservation and renewal of natural resources in the USSR is still not sufficiently recognized by the Soviet public and by many persons in planning, designing and economic management organs. There are still many organizations who spend their efforts on greater and more intensive utilization of natural resources, while the number and, what is more important, the actual influence of conservation-minded institutions are still very small. At the same time, the resolution of the 21st party congress calls for the further drawing of natural resources into economic circulation, meaning precisely the cycle of consumption and renewal.

The time has come to give up the naive faith in the inexhaustibility of natural resources; the time has come to pass from an extensive utilization of nature to a purposeful transformation of nature, i.e., a scientific organization of the resource cycle based on the same principles used in crop rotation to insure a steady increase in soil fertility through improved agricultural techniques.

It should be stressed at this point that the problem of the rational utilization of natural resources is far broader and more complicated than mere "conservation of nature." The latter concept simply involves the preservation of individual valuable landscapes or objects, removed for that purpose from utilization by man. While such conservation is undoubtedly important, the main objective of a Socialist economy is the rational utilization and expanded reproduction of natural resources.

The general concept "rational utilization of natural resources" includes several elements: study and mapping, economic appraisal and utilization proper, and the conservation and renewal of each resource and its territorial complexes.

Work on the study and mapping, as well as on the economic appraisal of natural resources, is being carried on a large scale and by many institutions in the USSR. They include the institutes, laboratories, councils and commissions of the Academy of Sciences USSR and the academies of sciences of the union republics (for example, the Councils for the Study of Productive Forces, the Institutes and Sectors of Geography, and Botanical, Zoological and Soils Institutes); the scientific institutes, administrations and production organs of the Ministry of Geology and Conservation, the National Academy of Agricultural Sciences named for Lenin, the Ministry of Agriculture (for example, the Main Administration of Forests and Shelter-Belt Management), the Ministry of Procurements (the Institute of Hunting and Fur Trapping); institutes, observatories and stations and the Main Administration of the Hydrometeorological Service (Main Geophysical Observatory, State Hydrological Institute, Central Forecasting Institute); the institutes and the map-compiling and editing sections of the Main Administration of Geodesy; the Main Peat Reserve Fund, and so forth. A major contribution is also being made by higher educational institutions, especially the Geography and Biology Faculties of universities.

The results obtained in the USSR in the study and mapping, as well as the economic appraisal, of natural resources are undoubtedly considerable. This is true, for example, of the vast amount of work to uncover and explore mineral resources done by the various organizations of the Ministry of Geology and Conservation and the geological, educational and production institutions of other agencies. Large-scale studies of climatic and water resources are also under way, mainly at the stations, observatories and institutes of the Hydrometeorological Service. These studies have yielded a large number of hydrometeorological handbooks, maps and surveys covering the country as a whole, as well as individual union republics and autonomous republics and groups of oblasts.

In the field of land resources, most of the practical work is being done by the land-use organs of the Ministries of Agriculture of the union republics, while most of the scientific research is conducted by the geography sections of the Soils Institutes of the Academies of Sciences of the USSR and the union republics, and the land-use institutes and faculties. Recently geographical research and educational institutions have also started to contribute actively to this work.

The study and census of natural fodder resources and forests are conducted by agricultural and forest-management organs as well as by scientific institutions, such as botanical, forest-management and fodder institutes.

Peat resources are also being studied systematically. The published materials (surveys, handbooks, maps) prepared on the basis of field studies of the Main Peat Reserve Fund could serve as an example for similar work on other natural resources.

Valuable work on a census of wildlife is being done in the Soviet Union by the Zoological Institute, the Institute of Hunting and Fur Trapping and the various nature preserves.

Despite the considerable volume of work already done or in progress, the present state of affairs is still inadequate to meet the present and expected needs of a rapidly growing planned economy.

First, the study, mapping and economic appraisal of most natural resources are not centralized and are being conducted by many agencies; many of them study the same resources without coordination. The only exceptions are the study of mineral resources and peat resources.

Second, most resource studies are done for the specific purpose of a given sector of the economy and lack an integrated approach. This interferes with a scientific organization of the work and with the utilization of its results by planning and designing organizations, especially in the formulation of economic development plans for the USSR and its regions. It is quite obvious that the thorough study and economic appraisal of natural resources requires not only investigation of the relevant resources but a

synthesis of all information about the territorial complexes of such resources in their mutual relations and interdependence. The problem thus becomes essentially a geographic one and geographers should play a central role in its solution.

In contrast to the geography of past periods, modern geography is concerned not so much with the study of little known and remote areas as with well known, heavily populated areas having a developed economy and a transformed natural environment. It is therefore the present central aim of geography to serve all branches of the economy concerned with the utilization of natural resources in seeking and justifying ways to rationalize such utilization and to combine the interests of the economy with a guided transformation of natural complexes. It is therefore up to geography to tackle one of the leading scientific problems of modern times -- the integrated study of the basic kinds of renewable natural resources and the formulation of methods for their appraisal, conservation and renewal. Soviet geographers are thus responsible to the nation for carrying out this key objective. What must be done to enable Soviet geographers to fulfill that task? What organizational steps need be taken? How are the forces of the geographic community to be marshaled for that purpose? It is hoped that the papers and discussion in the present symposium will supply an answer.

A great deal in improving the current status of studies of the natural resources of the USSR depends on the geographers themselves. Even if greater progress were being made in investigating individual types of natural resources, the study of the territorial complexes of natural resources would still lag far behind despite the fact that it constitutes one of the principal tasks of geography. The solution of that problem, besides having great practical importance, would also help rally the entire system of the geographical sciences around a common objective.

Territorial complexes differ in their resource associations. In some there is a great predominance of mineral resources, while climatic, water, land and biological resources are of lesser importance; others have a favorable combination of biological, land, water and climatic resources, with minerals playing a lesser role. Finally, there are complexes that seem to combine all types of natural resources.

The identification and typing of territorial complexes of natural resources constitute a challenging and practically significant subject of geographic research in the immediate future.

Such research should give priority to the study of energy reserves in the contemporary natural processes that tend to combine resources into a single territorial complex. Such a study should establish the relationship between inexhaustible, nonrenewable and renewable energy sources and between the corresponding types of mineral and organic raw materials. Geographers should direct their attention to a quantitative appraisal of various types of complexes because modern mass production requires both

an abundance of energy and raw-material reserves and natural resources that are of the highest grade and require the least expenditure for economic utilization.

We still lack a reliable scientific methodology for making an economic appraisal of natural resources, and especially of their territorial complexes. Such an appraisal belongs to the "boundary" area of geography requiring the joint efforts of physical and economic geographers, i.e., an especially close interrelationship and interpenetration of physical and economic geography.

Such an economic appraisal of individual types of natural resources must then lead to a classification into qualitatively different groups (quality assessment). Past practice has shown that such quality assessment is still largely arbitrary and should be based on more integrated methods taking greater account of the qualitative characteristics of resources, their quantitative indices, the geographic and economic aspects of their distribution, their relative location and the prospects of development in the light of scientific and technological progress. In the final analysis, an economic appraisal of natural resources should be designed to insure maximum labor productivity in their utilization, to gain the maximum amount of time in the peaceful economic competition between the Socialist and capitalist systems and to take account of the rate of exhaustion, renewal and increase of resource reserves.

The economic appraisal of territorial complexes of natural resources is especially complicated but has been studied to a greater degree in practice because the processes of utilizing one type of resource affect either favorably or adversely the utilization of others. The integrated development of the national economy also requires an integrated appraisal of natural resources. Such an appraisal can be expressed in value terms, in diagrams showing the interrelationships of natural resources and the advantages or disadvantages to be derived from simultaneous utilization of such resources, in concrete proposals of economic schemes for the utilization of resources and, finally, in the drafting of resource balance sheets. Such an appraisal and analysis can help achieve the greatest economic effectiveness and the largest savings in the utilization of natural resources.

An economic appraisal of the territorial resource complexes becomes especially important in connection with the drafting of 15-year-plan for the development of the Soviet economy. Scientifically grounded drafting of such a plan requires the carrying out of a general economic regionalization of the country. One of the key elements in such regionalization is the identification and economic appraisal of territorial resource complexes and their subsequent assignment to economic regions. It therefore becomes of the greatest theoretical and practical importance to work out scientific proposals for the integrated utilization of resources within the basic economic regions of the USSR. Such proposals could be used by planning, designing and other organizations, especially in regional planning.

The economic appraisal of resources and their specific utilization in production, as well as resource surveys for regional planning, require detailed resource mapping on a mass scale.

Serious progress has already been made in Soviet resource mapping, to which A. N. Baranov will devote a separate paper. We will simply list some of the major resource mapping projects: the first edition of the geological map of the USSR at 1:1,000,000; the soils map of the USSR at 1:1,000,000 and the vegetation map at 1:1,000,000, already completed for several regions in preparation for the compilation of the map of the USSR as a whole. Preparations are also under way for the compilation of a forest map of the USSR at the millionth scale. The value of all these maps, generalizing our present knowledge of individual resources, increases if they are used jointly. The use of these maps as a complex of maps of the natural environment of the USSR conveys their tremendous geographic significance and at the same time points up some serious gaps in that complex -- its incompleteness, its unjustified lack of agreement in the representation of interrelated phenomena, and its uneven degree of generalization. The compilation of a really valuable complex of resource maps of the USSR would require, first, coordinated methods and planning and, second, the compilation of additional sets of maps, such as a geomorphic map of the USSR at the millionth scale. It is unfortunate that the leading geographic institutions have not given sufficient attention to this problem.

While the creation of coordinated sets of resource maps constitutes a basic task for geographers, there is another area of resource mapping where geographers should carry the main burden of the work. That is the creation of integrated atlases of republics, oblasts and economic regions. Such atlases, constituting summaries of the present state of knowledge, are especially valuable for the integrated utilization (and renewal) of resources within the major territorial subdivisions of the USSR. Soviet Belorussia, which published such an atlas on its 40th anniversary, has provided the basis for such work in the post-war period. Similar atlases are in preparation in the Ukraine, Georgia, Armenia, Azerbaydzhan and the Central Asian republics. Moscow University is cooperating with the Main Administration of Geodesy and Cartography and with local scientific and government bodies in the preparation of atlases of Irkutsk and Kustanay Oblasts; Leningrad University in the preparation of atlases of Vologda Oblast and Komi ASSR; Rostov University in the preparation of an atlas of Rostov Oblast, and so forth.

The compilation of regional atlases makes it possible to use a vast body of diversified material, to a large extent unpublished, to compare, summarize and generalize it, and to present the results in economical, graphic and concrete form suitable for practical needs. This kind of work, usually undertaken on the initiative of the geographic community, not only rallies geographers around a project of national importance, but also attracts the forces of other research bodies and economic organizations and is always appreciated and supported by local party and government organizations.

The rational conservation and renewal of most natural resources can be insured in the following ways:

1. A continuing program of scientific exploration work designed to increase known reserves of a given type of resources, i.e., by new discoveries.
2. The use of exploitation methods under which the reserves and quality of resources increase in the process of utilization. Examples of such methods are a rational system of agriculture that maintains and progressively improves soil fertility, a correct system of forest management with artificial measures designed to speed regrowth, the development of steppes and deserts on the basis of reclamation work, and so forth.
3. The use of protective measures in all cases where accelerated or irrational resource utilization produces adverse effects, such as gullying and topsoil erosion on cultivated lands, pastures and pollution of the atmosphere, soils and water; reduction in the number of rare and valuable plants and animals, and so forth.

The USSR is carrying out several administrative, scientific and public steps designed to insure rational conservation and to protect resources against irrational utilization and exhaustion. The Academy of Sciences of the USSR has an active Conservation Commission in the Division of Biology. A great deal of useful conservation work is also being done by nature preserves. There has been an increase in the activity of societies that have conservation as their direct or incidental aim.

However, the measures taken to insure truly rational conservation and renewal of natural resources still appear to be inadequate. A much greater role in this national cause should be played by active members of the Soviet public, such as local-area students, members of societies, such as the Geographical Society, the Moscow Society of Students of Nature, the Society of Conservation and Urban Tree Planting, the young naturalists and other youth organizations. Their work should encourage both public conservation of natural objects and publicizing of the need for a careful attitude toward natural wealth and for further beautification of the Soviet Union.

While giving maximum attention to the public's role, we must at the same time remember that the key to the solution of the problem is improved economic planning of the rational utilization of natural resource complexes. This will soon require the creation of new governmental agencies capable of taking an integrated, planned and long-range approach to the study, mapping, economic appraisal, utilization, renewal and enrichment of the natural resources of the Soviet Union.

Such agencies should operate both at the national and at the local level. They should rely on the active collaboration of the many research institutions concerned with the study of natural resources. The main role and responsibility for resource studies should be assigned to geographic institutions. That is why we expect the present congress of the Geographical Society to adopt relevant decisions on that problem.

STUDY OF THE CLIMATIC RESOURCES OF THE USSR AND THEIR ECONOMIC UTILIZATION

By F. F. Davitaya, O. A. Drozdov, Ye. S. Rubinshteyn

Climate is one of the main factors of the physical-geographic environment. The close interrelationships between climate and the other components of the environment make the study of climate and the supplying of climatic data for practical needs a very complex task that can be solved only through scientific generalization of the observation data of meteorological stations.

In connection with the collection of weather data, the question of the principles and methods used to insure a correct distribution of meteorological stations becomes of paramount importance.

The meteorological network and its scientific principles of construction. Meteorological observations at individual points of the former Russian Empire operated even before the establishment in 1849 of the central meteorological institution, the Main Physical Observatory. In Leningrad (St. Petersburg) such observations have been conducted without interruption for more than 200 years. When the Observatory was organized, it was assumed that individual stations would be opened by interested agencies and that the Observatory would simply direct the operations of the stations, as well process and publish the observation data. Experience showed, however, that the number of stations increased very slowly, reaching only 24 by 1864. Subsequently growing needs spurred a more rapid expansion of the meteorological network, which comprised 1,416 stations by 1914.

In addition to stations that carried out a more or less complete program of observations, there were also so-called rain-gauge stations, concerned mainly with precipitation, as well as snow cover and storms.

There were about 250 rain-gauge stations in the 1880's, about 2,000 in the 1890's and 1,470 in 1914. The reduction in number is explained by the fact that local organizations often established temporary high-density networks of stations for agricultural purposes and that some of these stations were later converted into regular meteorological stations.

World War I and the subsequent civil war and foreign intervention led to the destruction of a large part of the meteorological network and the loss of observation data. In 1920 the Observatory received records from only 200 full-fledged stations and 125 rain-gauge posts (now called posts); in other words the young Soviet republic had been thrown back forty years and a meteorological network had to be created virtually from scratch.

The main defect of the pre-revolutionary network was its unplanned growth, resulting from the fact that most stations were set up by various agencies. Such a system led to saturation in some parts of the country and a total absence of stations in others. In addition, the network was extremely unstable, with stations, including often very valuable ones, being closed as the need arose.

On June 21, 1921, the Council of People's Commissars issued a decree ordering the planned restoration of the meteorological network. However the People's Commissariat of Education, which was then in charge of the Main Physical Observatory, lacked the necessary funds and the meteorological network was restored largely by various agencies, with all the defects inherent in such a system. By the late 1920's the situation had become intolerable, and soon after a single Hydrometeorological Service had been established, it urged the Main Geophysical Observatory in 1932 to work out a set of scientific principles for the reorganization of the meteorological network. This was done and the results were published in a series of scientific papers. We should like to review the ideas proposed by Soviet climatologists for the solution of the above-mentioned problem.

The development of a theory of climate and the proper availability of weather and climate data for practical needs require the construction of a meteorological station network such as to make possible the calculation of the values of meteorological elements for any intermediate point on the basis of the values observed at the stations. Each meteorological element has its own characteristics with respect to its distribution in space (continuity or discontinuity of the field, magnitudes of horizontal and vertical gradients, and so forth). Theoretically speaking, the question of the rational construction of a meteorological network should therefore be solved for each meteorological element separately. It follows that the program of observations does not have to be identical at all stations.

The meteorological network should constitute a scientifically grounded system of stations, each member of which occupies a definite place both in its territorial location and in the program of observations (network density and its structure -- station types).

The characteristics of the meteorological fields of air temperature, humidity and cloudiness, as well as of the atmospheric pressure field, were studied by Soviet scientists as early as the 1920's. For that purpose they computed the year-to-year variability of the difference in the simultaneous values of meteorological elements between two points situated at various distances from each other. It turned out that for interior continental lowlands the variability of the differences was a linear function of the distance between the two stations, even if the distance reached hundreds of kilometers. In mountain areas the variability also had to take differences in elevation into account.

These studies applied to monthly averages and were conducted for the purpose of improving the climatological processing of data and the construc-

tion of climatic maps. However, the linear character of the relationship also holds true for daily values.

In other words, data on the character of the meteorological fields of temperature, pressure, cloudiness and humidity are extremely useful for the rational construction of the meteorological network.

The territorial distribution of precipitation and the snow cover is more complex. The fields of these elements have frequent continuity breaks, and the variability depends on the absolute values of these elements. For example, the relative variability of precipitation is smaller at a station with high precipitation than at a station with low precipitation, and the relationship between the amounts of precipitation at two stations with unequal averages is nonlinear. It follows that interpolation of precipitation data requires first their reduction to a single dispersion, i.e., the use of their relative variability.

Since the proper construction of a meteorological network must make possible the interpolation of values of meteorological elements for any point, we can give a formula to calculate the interpolation error for those meteorological elements whose values in various points (A and B) have a linear relationship:

$$\sigma_c^2(\rho, n) = n\,\sigma_d^2\left[(1-n)\rho\right] + (1-n)\sigma_d^2(n\rho) - n(1-n)\sigma_d^2(\rho)$$

where ρ is the distance between points A and B; σ_d is the quadratic deviation of the differences of the meteorological element at these points; n is the ratio between the distance from one of the stations to intermediate point C and the total distance ρ; c is the difference between the observed and interpolated magnitudes at point C, σ_c is the average quadratic deviation of magnitude c.

For those meteorological elements (precipitation and snow cover) where the relationship between the values at various points depends on the absolute magnitude of the elements, we must calculate not σ_c but $\frac{\sigma_c}{\bar{c}}$, where $\bar{c}$ is the average value of the magnitudes of c (O. A. Drozdov and A. A. Shepelevskiy, 1946).

If the desired accuracy of the interpolation is given, i.e., if the magnitude of σ_c or $\frac{\sigma_c}{\bar{c}}$ is known, the formula makes it possible to calculate ρ, the distance between points A and B for which interpolation is possible at intermediate points with the desired degree of accuracy.

In applying the formula in practice, it should be borne in mind that the differences in the corresponding values of meteorological elements at two points depend not only on the distance between the points, but also on the difference in the character of the underlying surface and characteristics of the atmospheric circulation. In determining the rational distance between stations, stations should be used that are located so far as possible under identical conditions. Only then should corrections be made in the

interpolated magnitudes on the basis of known changes in the values of meteorological elements in accordance with elevation above sea level, relief forms, distance from the sea and other landscape elements.

The distances between stations of a rationally constructed network vary for each meteorological element, and exact implementation of the above-mentioned method would yield a very complex station network. Calculations based on actual observation data show that the distances for various meteorological elements can be grouped by orders of magnitude. Observations of precipitation, snow cover, rain storms, fogs, snow storms and glaze should be conducted at points 10 to 20 km. apart, and interpolation is possible only for ten-day snow-cover averages and monthly averages of the other elements. Daily observations of temperature and humidity and cloudiness can be interpolated with a sufficient degree of accuracy between lowland stations 50 to 60 km. apart. Even greater distances between stations are permissible for the interpolation of atmospheric pressure.

In mountain areas, near seas, large lakes, and so forth, additional stations are required for the construction of cross sections characterizing the effect of these features on the meteorological conditions of the territory.

The smaller the value of δ_c in the formula, the greater is the accuracy of interpolation and the smaller is the distance between stations. However, for certain distances between stations, the interpolated values become as accurate as the observed values and there is then no further need to bring the stations closer to each other. This is due to the turbulent structure of the atmosphere, the accuracy of the instruments, as well as the effect of the microclimate, which should not be taken into account in the construction of a rational station network. Microclimatic characteristics should be studied by means of temporary stations, traverses and so forth, tying in the results with the data of the permanent stations.

The minimum distances, beyond which stations need not be brought closer to each other, vary with different areas and different meteorological elements. In the case of temperature and humidity, the minimum is 50 km. in lowland areas.

On the basis of this method, we can construct a basic network of meteorological stations necessary and sufficient for the interpolation of values of meteorological elements at any intermediate point on the basis of data from the network stations.

Experience shows, however, that in addition to the basic network supplementary stations must be established for special purposes, such as aviation and agriculture. Although most of the stations of the basic network also serve various sectors of the economy, there is a substantial difference between the observations required from the basic stations and those from the supplementary stations. The basic stations should so far as

possible follow a stable schedule, work on the basis of a single list of instructions, and be located in places that are typical of the larger surrounding area. The special-purpose stations, on the other hand, should operate only when needed and in places relevant to their purpose.

Similar principles should be used for construction of a network of weather posts.

These principles and methods of constructing a meteorological network were basically worked out before World War II, but were subsequently checked and refined for individual meteorological elements (snow cover, rain storms, soil temperature). In past years a great deal has been done to reorganize the station network in accordance with these principles; however, for various reasons, that work has not been completed.

The Soviet Union now has about 4,000 meteorological stations, 90 per cent of which are under the jurisdiction of the Hydrometeorological Service (more than 2,000 of them conduct agrometeorological observations for agricultural purposes).

The other stations belong to the Main Administration of the Northern Sea Route or to various other agencies and are designed for special purposes (university and college stations, experimental farm stations, forestry stations and so forth).

If we consider that distances between stations in the lowland of the European part of the Soviet Union should be about 55 km. (i.e., an area of 3,000 sq. km. per station), the station network over most of the area must be regarded as excessively dense and some of the stations should be assigned to the supplementary category. At the same time, the Carpathians and the higher part of the Urals have too light a coverage. The situation is even worse in Western Siberia, Cisbaykalia and Transbaykalia, which despite a complex relief have only one station per 6,000 sq. km.; in Krasnoyarsk Kray, with one station per 14,600 sq. km., and in Yakutia, with one station per 23,100 sq. km. This is of course due to the sparse population of these areas, but with every passing year new areas are being settled and the station network is being expanded. The present objective should be to insure the proper distribution of stations in areas having an adequate network and to exclude superfluous stations from the basic network.

As for newly settled areas and mountains, attention should be concentrated on the correct location of new stations.

The number of posts making observations of precipitation exceeds 12,000, of which 5,000 are agrometeorological posts on the territories of collective and state farms. The total number of points carrying out observations of precipitation (stations plus posts) is still inadequate over most of the territory of the USSR, even if only settled areas are taken into account.

Generalization of weather data for climatological purposes. The following considerations must be borne in mind in data generalization: (1) What climatic indicators best characterize climate? (2) How are these indicators best compared in space and in time?

For a study of the theory of climate we must know which atmospheric processes resulted in the formation of the given climate, what weather types resulted from these processes and what numerical values they yielded for individual meteorological elements. All these data are necessary for a knowledge of the climate-forming processes, for long-range weather forecasts and for calculations relating to man's attempts to change climate.

For a solution of applied problems in climatology we need other climatic indicators, namely the basic climate characteristics expressed in numerical form for certain meteorological elements or their combinations. Such data are required, for example, for the designing of structures and buildings, for city planning, for working out some technological processes in industry and so forth.

No matter which climatic indicators we use, whether data for individual meteorological elements and their combinations, or synoptic climatic characteristics, or calculated data, in all cases two questions are of paramount importance: the establishment of homogeneity in the series of observations, and the conducting of the series of observations over a long period.

The average values of meteorological elements are especially sensitive to any disturbance in the homogeneity of the series of observations, and in the case of some elements the repetitiveness of values at certain intervals would be affected.

There may be various reasons for actual or apparent lack of homogeneity: (1) climatic change, (2) change of the microclimate in the station area, (3) substitution of one type of instrument for another, (4) change in observation methods, (5) subjective readings by the observers in visual observations.

Establishing the causes of a lack of homogeneity is of decisive importance in the question of whether the whole series of observations or only a part is to be used, and, if so, which part.

In view of the great variability of most meteorological elements from year to year, and in view of the fact that many parts of the earth have witnessed climate changes or fluctuations in the last 30 to 40 years, the computation of long-term monthly averages of these elements requires a period of observations of the order of 50 to 70 years. For the computation of integrated climate characteristics with a sufficient degree of accuracy, even longer periods are required. The use of observation data accumulated over periods of varying duration and especially over too short a period can lead to serious errors not only in the accuracy of the absolute magnitudes

but in distorting the relationships between the climates of various areas. As an example we might note that average monthly cold-season temperatures computed for several ten-year periods can differ by as much as 5 to 7° C, average amounts of warm-season precipitation can differ by 50 to 60 per cent, and annual amounts of precipitation even more. If we bear in mind, moreover, that climate changes in various areas are not synchronous, it becomes clear what serious errors can result from the use of observation series of insufficient duration.

With a view to insuring comparability of climatic data computed for varying periods, Russian climatologists have worked out a theory for converting observation series to a longer period. In pre-revolutionary times such conversion was based on certain empirical principles and was used only for average monthly temperatures and total amounts of precipitation. The great development of climatology after the Bolshevik Revolution and the organization of new stations made it necessary to work out the conversion to a long period on a stricter basis.

This was done by Soviet climatologists, and we now have a complete theory for converting observation series. The theory is used in the climatological processing of nearly all meteorological elements to yield long-term averages and, in the case of some elements, even extreme magnitudes and the degree of repetition of the values of a given element at various intervals (Kurs klimatologii, 1952).

In view of the great year-to-year variability of meteorological elements in temperate and polar climates, the great expansion of the meteorological network through the development of former uninhabited areas, and the instability of the network, the study of homogeneity of series and the formulation of a theory for converting series to a long period played a key role in insuring the fullest utilization of observation data for the formulation of a theory of climate and for the practical utilization of climatic resources.

The problems discussed thus far apply to all methods of climatic characterization. We will now turn to specific problems.

The first integrated characteristics of climatic conditions were computed as early as the beginning of the last century in connection with the empirical study of evaporation. The number of such characteristics increased subsequently, and in the last 50 years some of these characteristics have become virtual indices characterizing the degree of moisture, the rate of cooling, the severity of weather and so forth. In the 1920's meteorologists worked out scales of effective, and later resultant, temperatures, evaluating man's comfort in terms of temperature, humidity, wind and solar radiation. The development of such integrated concepts was further promoted by studies of the relationships between the heat and water balance and physical-geographic zonality, conducted by A. A. Grigor'yev and M. I. Budyko. Similar balance characteristics are now being worked out in connection with the bioclimatology of man.

The mechanizal integration of weather elements also originated a long time ago, at first in the form of combinations of wind and several other elements. An integrated concept worked out in the 1920's by Ye. Ye. Fedorov and several Americans was at first thought to have universal applications in all climatological problems. Later it became clear that various integrated concepts and various gradations of meteorological magnitudes were required for various purposes. This resulted in the appearance of a large number of systems of integrated characteristics, and weather analysis had to make use of all possibilities of meteorological observations. All the necessary, though still far from universal, characteristics could be obtained rapidly only by mechanization.

The great variety of present-day requirements makes necessary the use of increasingly diversified characteristics. For example, the study of range grazing of livestock requires data reflecting difficulties in the use of pastures (glaze, snow depth, snow storms); the designing of river reservoirs requires data on wind-drive (sgonno-nagonnyye) phenomena (the velocity of continuous winds blowing along the entire length of the reservoir).

The study of the weather of pressure systems began at the end of the 19th century. In the 1930's, when the air-mass concept was first introduced into synoptic work, climatic air-mass characteristics also made their appearance, reaching their greatest perfection in B. P. Alisov's work. At the same time, climatologists began to study the climatic characteristics of long-term forecast patterns, especially by G. Ya. Vangengeym's method, which is important for insuring the accuracy of forecasts. In addition, climatologists studied the synoptic picture characterizing various other climatic phenomena (trade winds, monsoons, the characteristics of average pressures, orographic frontogenesis and so forth), which made it possible to clarify major aspects of the genesis of these phenomena. The use of systematic catalogues of processes, according to G. Ya. Vangengeym and B. L. Dzerdzeyevskiy, made it possible to relate the genesis of climate changes and fluctuations to synoptic processes. At the present time synoptic climatology is becoming increasingly the basis for long-range, and especially extra-long-range, weather forecasts.

Physical calculation methods began to be introduced into climatology in the 1920's in connection with the development of the physics of the surface layer, but these methods were not really developed until the 1940's. The characteristics of exchange in the surface layer can now be determined by calculation. There are several studies characterizing the heat exchange and moisture exchange in the atmosphere on the macro-scale. The most productive is the semi-empirical approach used by M. I. Budyko, M. I. Yudin, M. Ye. Shvets and others. Similar studies illuminate various aspects of climate genesis and make it possible to predict the consequences of the transformation of nature in large-scale reclamation programs. Such predictions are difficult by any other method. In view of the fact that there is no past experience with such large-scale projects and there are no analogues under similar climatic conditions, the comparative geographic method cannot be used in this case.

Finally, we should say a few words about the new landscape trend in climatology. We know that on a small areal scale the climate, or rather microclimate, changes with the landscape and is a function of the natural landscape units. The study of local climatic characteristics together with integrated physical-geographic work could be one of the most fruitful aspects of microclimatic investigation. The climate of an oasis, for example, does not coincide exactly with the extent of the oasis because of the effect of advection, even on a small scale. The oasis climate is expressed least on the windward side of the oasis, while on the leeward side the oasis climate extends far into the desert. In larger regional units, climate determines the landscape characteristics to a greater degree, being itself a function of those characteristics. The development here of a rational form of landscape and climatic investigations is a matter for the future. As far as the basic chorological unit of landscape is concerned, although it is asserted that a landscape has its climate, there may be some doubt about that.

A landscape constitutes a system of combinations of smaller components, many of which are found in other combinations in adjoining landscapes. It would be more correct to say that landscape is characterized not so much by a given climate as by a distinctive combination of microclimates. The areal extent of a landscape is too small to allow it to form a real climate substantially different from the climates of adjoining landscapes because climates are formed by processes operating at huge scales in the earth's general atmospheric circulation.

Various trends in climatological studies. The science of climate has developed and become differentiated to such an extent that it is difficult to find a specialist who could work productively in all its aspects, not to speak of its applications in other fields of knowledge or sectors of the national economy. Climate, as a natural factor, is so diversified that its study from all points of view has required the use of a whole arsenal of methods and has brought about several trends in general climatology, which will be discussed below.

The study of climate for the specific purposes of economic production and culture, taking account of specific effects and mutual interactions, has turned out to be even more complex and difficult. There is no such thing as applied climatology "in general", if we consider the general fundamental principle that the subject of investigation of such a discipline is the study of relationships between sectors of production and climatic factors for the purpose of using climate as a natural resource (for example, in agriculture or electric-power generation), and ways of overcoming all harmful manifestations of climate (in all fields of application) by transforming climate by various means or by adapting production to the given climatic situation. If we are to do successful work in this field, we must be equally familiar with climatology and with the field of application. The need for thorough knowledge of both disciplines nowadays virtually eliminates the possibility of advanced work on the natural laws studied by still other disciplines. This shows that there is no basis for talking about an applied climatology in general.

It is clear that any such boundary problems can be studied either by climatologists or by specialists of the applied disciplines.

The most highly developed of these applied sciences is agricultural climatology, in which physical, geographic and agrobiological laws enter into play. The principal Russian contributions to this field were made by A. I. Voyeykov and, in Soviet times, by P. I. Koloskov, G. T. Selyaninov, F. F. Davitaya, S. A. Sapozhnikova and I. A. Gol'tsberg. Work is also being done in medical, construction, transportation, aviation and other aspects of climatology.

These various trends developed in general climatology as a result of the differentiation of methods that must be used in studying climate from all viewpoints.

At first, climatologists studied individual climatological elements in terms of their average values and their fluctuations. This was the natural initial stage of the study of climate. It uncovered the major characteristics of climate and its changes as well as its major relationships with vegetation, soils and other components of the natural environment. A similar approach is now being used in the applied fields of climatology (for example, the sums of temperatures in agriculture, and the calculated ventilation temperature, the calculated wind velocity etc. in technology). The relative accessibility to such data and the simplicity of operating with them have resulted in the widespread use of this approach, which is still the dominant one in the field. It should be pointed out, however, that it does not take account of relationships between elements of the weather complex, that it limits the study of temporary relationships and ignores a large part of the spatial relationships observed in specific weather types.

Another approach to the study of climate involves the integration of the natural weather elements, say, in the course of a day, as has been done by the integrated method of Ye. Ye. Fedorov and L. A. Chubukov. Such a method takes account of the relationships between the weather elements, but it makes the study of climate over time more complicated than the preceding method. Because of the need for using major gradations in the degree of repetition of individual magnitudes in the integrated groups of weather elements, this method both simplifies and complicates the study of spatial weather relationships. A mechanical breakdown of weather into integrated groups of elements makes it possible to bring out several fine characteristics of the structure of climate, but is too cumbersome and unsuitable for several applied fields. It is impossible to create a single integrated group of elements suitable for use in any applied field, and therefore a large number of integrated climate characteristics must be worked out for various purposes. This greatly complicates the problem, which can be solved only through the wide use of mechanical processing of the results of meteorological observations.

Of the greatest interest are integrated climate characteristics that

express the effect of climate on a given object, such as conditions of cooling and heating (including man's sensitivity to heat) and conditions of evaporation (including the desiccating effect of sukhovey, or dry desert winds). Similar integrated climate characterisitcs, such as water-and-heat coefficients, can be calculated empirically or can be derived from the conclusions of strictly physical theory (as M. I. Budyko has done). Such integrated concepts are especially widespread in agricultural climatology (G. T. Selyaninov, N. I. Ivanov, Ye. A. Tsuberbiller) and in medical climatology (V. A. Yakovenko).

A third type of climate characteristics may be called natural-synoptic characteristics. They represent a natural combination of weather conditions resulting from certain processes and situations in the atmosphere. Information on such characteristics is especially valuable for long-range, and sometimes even for short-range, forecasts, and must be regarded as a component part of synoptic climatology.

Synoptic climatology looks at climate in relation to circulatory processes. It is often called dynamic climatology. But that is an incorrect designation. The dynamic character of phenomena depends not only on the weather, and not every synoptic situation characterizes the dynamics of climate. However, by uncovering certain conditions in the genesis of climate, synoptic analysis makes it possible to confirm climatic laws established by other means and to obtain the weather characteristics of given snyoptic situations. The first result is of importance to general climatology, while the second is significant for applied climatology and can be used to improve weather forecasts. Of course, general climatological laws in any form can also contribute much to the improvement of forecasts.

In those cases where the characteristics of weather do not depend on its genesis, the consumers of climatological expertise are not interested in the purely physical aspect of weather processes and prefer direct climatic servicing.

A distinctive approach in climatology is the method of physical calculations. Although calculations based on a knowledge of physical or or physical-statistical laws are used in several methods, these are employed especially in calculations of the heat and moisture balance and of the amount of movement. In view of the complexity of problems in theoretical climatology, the hydrothermodynamic method in its pure form has not been too productive thus far. Nevertheless its conclusions about the nature of climatic processes are of importance (V. V. Shuleykin, M. Ye. Shvets, M. I. Yudin). More commonly, in addition to theoretical conclusions, this method involves the use of a vast amount of empirical data (M. I. Budyko, D. L. Laykhtman, M. I. Yudin, M. Ye. Shvets). As was noted earlier, a similar semi-empirical approach is, as of today, the most productive way of applying theoretical findings to climatology. The method of semi-empirical analysis, used by M. I. Budyko, made it possible to find deep agreement between the heat and water balances, on

the one hand, and physical-geographic zonality, on the other. Finally, we have a group of studies that look at climate as one of the characteristics of the geographic landscape (A. A. Borisov). Such an approach, together with the balance calculation, is of considerable interest to landscape studies and physical geography as a whole.

It goes without saying that the various approaches discussed above do not contradict, but rather supplement, one another. In the past, differences in approaches to the study of climate have unfortunately often been reduced to the absolute. A certain approach was regarded as correct, and all others were then ignored. The fact is that none of the above-mentioned approaches can alone solve the problems of climatology, not to speak of the fact that the application of, say, the method of integrated climatology to even the simplest problems is extremely cumbersome. Nor should we attempt to solve all problems in climatology just on the basis of the synoptic, landscape or balance approaches. Attempts to raise any of these approaches to a dominant position have only brought harm in the past. In a sharply accentuated form this gives the method priority over the object of study or stresses general problems at the expense of applied problems, as in the case of G. I. Vil'd or in several articles published in the last decade for discussion purposes. In contrast, the approach advocated by A. I. Voyeykov looks at the method merely as a means of solving a given problem, whether in theoretical or in applied climatology. Just as dangerous is the occasional underestimating of general climatological studies and the emphasis given to problems of applied climatology relating only to agriculture.

The existing division of labor in climatological research often makes it impossible for one group of climatologists to use the complete arsenal of methods and data available to followers of another approach; however, a start has already been made toward the interpenetration of all these approaches. The problems now faced by climatology can be solved only through the use of the various approaches.

Basic studies on the climate of the USSR. The gradual accumulation of observation data led to the publication of scientific generalizations of these data. In listing only the most important studies relating to the country as a whole, we must mention, first of all K. S. Veselovskiy's O klimate Rossii (The Climate of Russia), published in 1857, about which the Council of the Geographical Society wrote that it "belongs to those major works that laid a firm foundation for the proper development of entire branches of scientific literature." This study is in the nature of a monograph containing a very interesting text and information on several meteorological elements. The numerical data refer to 57 stations. In the 1870's and 1880's there was a sharp increase in observation data and the subsequent climatological studies were monographs on individual meteorological elements (G. I. Vil'd, M. A. Rykachev, A. A. Kaminskiy, I. A. Kersnovskiy, A. A. Tillo). Some of these studies included climatic atlases as appendices.

In 1884 A. I. Voyeykov published his classic study Klimaty zemnogo shara, v osobennosti Rossii (Climates of the Earth, Especially Russia), in which the author concentrated his attention on climate-forming processes and their interrelationships.

The Klimatologicheskiy Atlas Rossiyskoy Imperii (Climatological Atlas of the Russian Empire), published in 1900, consisted of 89 maps compiled by the staff of the Main Physical Observatory. The atlas, outstanding for its time, made a deep impression among scientists throughout the world.

In 1914 staff members of the Main Physical Observatory began work on a complete climatological treatment of Russia. A. I. Voyeykov participated in that project.

This treatment was conceived as a series of monographs dealing with individual meteorological elements and containing numerical data, climatic maps and a text with a scientific generalization of the used data. The First World War and the events of the early post-revolutionary years interfered with progress on that project. In the late 1920's, when the reconstruction period ended and the country's industrialization and agriculture started to develop, it became clear that the national economy needed in the first place numerical climatological data. In addition to the monographs on individual meteorological elements making up the series Klimat SSSR, this economic requirement led to the speedy publication in 1931 and 1932 of two issues of Klimatologicheskiy Spravochnik (Climatological Handbook), containing data for most of the Soviet Union. Further development of industry, agriculture and culture required a revision of these handbooks, including data for a larger number of stations and for a broader observation program. This revision was carried out on the basis of a uniform methodology and program and resulted in the publication of 27 volumes for the whole USSR during the period 1945-50.

The next stage in the complete climatological treatment of the USSR was the compilation of Klimaticheskiy Atlas SSSR. This work was done mainly on the basis of the numerical data published in the revised Klimatologicheskiy Spravochnik. The atlas is being published in two volumes containing a total of 427 climatic maps.

In preparation for the atlas project, climatologists acquired a certain amount of experience by participating in the compilation of other physical-geographic atlases. The Bol'shoy Sovetskiy Atlas Mira (Great Soviet World Atlas) contained 49 climatic maps and the second volume of the Morskoy Atlas (Marine Atlas) contained 84 original maps out of a total of 138. Special mention should be made of the maps of the components of the heat balance, compiled for the first time for the USSR and for the world as a whole.

The compilation of maps for the Klimaticheskiy Atlas was greatly

complicated by the existing distribution of meteorological stations. Even now, huge parts of the USSR with complex relief and areas larger than some European countries do not have a single meteorological station. The drawing of isolines under such conditions required great caution and could not be done merely on the basis of a formal spatial interpolation of the values of meteorological elements. The map compilers had to calculate the effect of elevation, relief form (slope, valley, plateau), orientation of slopes, and large water bodies.

At the present time work is being concluded on the third stage of the complete climatological treatment -- the writing of climatic descriptions of the USSR for its eight major physical-geographic regions.

When all this work was done, it became clear that the needs of the national economy dictated the compilation of climatic atlases for individual oblasts and krays of the Soviet Union on a scale larger than for the USSR as a whole, and correspondingly detailed climatic descriptions of oblasts and krays. This should be done whenever a given oblast or kray has an adequate coverage of meteorological stations.

Several important laws have been established in the process of the study of climate of the Soviet Union. The most important of these for physical geography is the fluctuation of climate over time.

It is a well established fact that climate has changed in the last 30 to 40 years. If that change was formulated at first as a "warming of the Arctic," it is now known that climatic change has affected the whole world. At the time of the very cold winters of the early 1940's, some scientists suggested that the period of warming had ended. Actually the situation is not that simple.

We can briefly formulate the present status of that question as follows:

1. Temperature changes are essentially wavelike in character.
2. The area covered by synchronous fluctuations, its geographical location and the amplitude of the fluctuations vary at different times of the year. The greatest amplitudes usually occur in winter, and the smallest in late summer and early autumn.
3. At high latitudes winter temperatures are even now still above the norm (Barents Sea, lower courses of the Ob' and the Yenisey). For example, in January 1955 the deviation of the average monthly temperature from the norm at Turukhansk was $+12^{\circ}$C, and in December 1951 and 1953 about $+9^{\circ}$. At Verkhoyansk the ten-year averages of the monthly temperatures from November to February in the 1930's and 1940's were 3.5 to 4° higher than in the 1880's and 1890's.
4. In Central Asia and in the Caucasus, the temperature changes are in opposite phase to the changes in northern areas.
5. Of considerable interest at the present time is the increase in temperature in April in Western Siberia, especially in the basins of the

Yenisey and Ob' rivers (Turukhansk, Salekhard). The ten-year averages after 1940 have been 6 to 7° higher than in the 1880's and 1890's. In Barnaul the ten-year averages have risen by 5° in recent years. Similar rises of the April temperature are evident in other areas.

6. In periods of considerable warming there is a sharply expressed tendency toward a predominance of warm years, but there are also individual years that are very cold and immediately follow or precede very warm years. In Leningrad, for example, the average January temperature was -2.2° in 1949 and -13.9° in 1950; in Turukhansk, the average December temperature was -17.6° in 1951 and -31.1° in 1952 (Ye. S. Rubinshteyn, 1956).

The utilization of climatic resources in the national economy. The results of studies of the country's climatic resources are widely used in the national economy. The fundamental work in that field was done by K. S. Veselovskiy, A. I. Voyeykov and P. I. Brounov. Their studies appeared primarily in pre-revolutionary times and utilize climatic data mainly for agricultural purposes and for the planning of resorts. The progressive ideas contained in these studies have been developed far more intensively in the USSR (and now in the people's democracies) than elsewhere in the world, largely because of the advantages of the Socialist system. The most important of these advantages is planning, which has replaced the former haphazard process regulated by the law of surplus value with its inherent system of competition and leading in the final analysis to irrational utilization of natural resources and their exhaustion.

The problem of rational utilization of climatic resources has been advanced to the greatest degree with regard to agriculture. Similar investigations are concerned with public health in the broad sense, transportation, industrial and housing construction, electric power development and a few other economic sectors.

These investigations have established the principle that, as productive forces develop under a highly advanced and constantly developing form of productive relations, the need for taking account of the factor of climate and weather in man's activities does not diminish, as once supposed, but, on the contrary, constantly increases. The methods of studying climate and weather and the ways of utilizing them for man's benefit become increasingly complex. This is explained by the fact that the interconnections and interrelationships between man and his natural environment become increasingly rich, diversified and close as man learns to recognize the laws of nature in accordance with his growing needs.

At a time when there were no railroads and highways, snow drifts or washouts produced no major obstacle to primitive means of transportation and were of little interest for scientific study. Before the advent of aviation little attention was paid to ceiling, icing, visibility and so forth. As aviation developed, its weather and climate requirements became increasingly complex. In the early days of light planes, pilots required only

information on ceiling, wind in the surface layer of the atmosphere and visibility. Now, in the days of high-speed aviation, they must also have data on the vertical distribution of winds and clouds, icing, turbulence, the presence of jet streams, electrical discharges in thunderstorms and many other factors.

At a low level of agricultural development, cultivators took account of weather and climate by groping their way and only in the most general terms. Farm production remained low in quality and quantity, and the relationship between the size of the harvest, on the one hand, and weather and climate conditions, on the other, was often obscured by other factors. With an improvement in field cultivation in accordance with existing and expected weather conditions, the introduction of new high-yielding varieties, the planting of windbreaks and the general rise in the level of farming techniques, cultivators found it necessary to take detailed account of all the components of the water and heat balance of the fields. This resulted in a sharp increase in the coefficients of correlation between good harvests and favorable weather conditions. In some cases the relationship between them actually approached that of a mathematical function.

The same situation exists in other sectors of the economy that are directly or indirectly affected by weather and climate. As long as man did not understand the laws by which weather and climate operated, he was at their mercy. The more he begins to understand these laws, the more he is able to direct the effect of weather and climate along beneficial lines, using the good to the maximum and neutralizing the bad, and the more he frees himself of the forces of nature that restrict his activities.

Work on problems in applied climatology also required a fundamentally fresh approach for appraising the climatic resources of an area. The relative significance of the various climatic components varies widely for different sectors of the national economy and even for individual objects within a given sector. Climate is a combination of a large number of factors (temperature, precipitation, humidity, wind, cloudiness and so forth). All interact among themselves and with other components of the natural environment and together form the environment of any given part of the earth. However, many of these factors may be entirely irrelevant for certain objects of production or at best may be only of indirect consequence.

With regard to living objects (plants, animals, micro-organisms), this is reflected in the law of the unequal effect of environmental factors. The annual trend of temperature, for example, is one of the main criteria for climatic classification and regionalization, but winter temperatures are of no significance for annual crops cultivated only during the growing season. The annual trend of precipitation is another important climatic criterion but in itself is of little significance for solving many agricultural problems. The law of the unequal effect of environmental factors also applies to inanimate objects. A major climatic index for overland transportation is the degree of repetition of intensive precipitation, causing washouts in spring

(meltage) and summer and snow drifts in connection with strong winds in winter. Another major transportation factor is temperature fluctuations causing the ground to freeze and to thaw. Other climatic factors, such as atmospheric pressure, air temperature and humidity, cloudiness and sunshine, are of little importance in transportation.

An economic appraisal of climate therefore presupposes the determination of the relevant climatic indices for any given object and study of the long-range behavior of such indices. These indices can be used for practical purposes to establish the similarity of climates in entirely different natural zones and, on the other hand, substantial differences in climatic conditions within a given natural zone. This idea has been developed thoroughly in agricultural climatology. The studies in that field are of the greatest practical significance and are also helping to solve several problems in the theory of climate formation.

Such studies are acquiring increasingly current importance with the development of agriculture in the Soviet Union. That is quite understandable. Climate has an important effect on the geographical distribution of crops and livestock, on their growth and development, and on the yield of crops and the productivity of livestock. Climatic conditions determine to a substantial measure the effectiveness of various crop-raising and stock-breeding methods and affect the productivity and quality of the work done with farm machines and implements. In the zone of crop and livestock production, climate in turn depends to a ma. . degree on man's productive activity. Climate undergoes substantial changes in accordance with the use of certain crop and livestock production systems and given methods of cultivation, irrigation, water spreading, drainage and other reclamation measures. The higher the level of agricultural development, the closer are these interrelationships. Knowledge of the laws of formation of the climates of soils and of the surface atmospheric layer makes it possible to guide these climates toward beneficial effects through the use of optimal cultivation methods, changes of planting dates, selection of appropriate crops and varieties, planting of windbreaks and so forth. That is why recent party and government decisions have emphasized the need for avoiding stereotyped methods in agriculture and adopting differentiated methods taking account of local climatic and soil conditions.

Major studies of the agroclimatic resources of the USSR have been carried out in the Soviet period with respect to subtropical crops, winegrowing, cotton, grain, vegetables and some industrial crops. These studies have been of considerable help to farm production and have helped develop methods for specialized climatological investigations. One of these is the widely applauded method of forecasting the climatic conditions needed in any given area for any given type of agricultural production.

A great deal of work has been done in the study of the agroclimatic and water resources of the virgin and idle lands, the central parts of European Russia, Kazakhstan, Western Siberia, the Yakut ASSR and the Soviet Far East.

The Hydrometeorological Service began in 1954 the compilation and publication of agroclimatic oblast handbooks. These reference books can be useful for planning agencies as well as for the directors of state farms, collective farms, machine-tractor stations and local agronomists. Among the data given in these handbooks are the optimal and extreme planning dates, dates of phenological phases, water requirements of plants in various periods of development, the likelihood of frosts and other indices. Eighty such handbooks have been published thus far. The remaining 34 books are to be published within the next year or two. This has been a tremendous project without precedent in world literature.

Methods of agroclimatic regionalization have advanced to such an extent that the ready-made long-term average data of the ordinary network of meteorological stations together with microclimatic reconnaissance surveys of a given area in one or two growing seasons are now sufficient to construct an agroclimatic map of any area down to individual collective or state farms, just as soil scientists now compile similar large-scale soil maps. This method makes it possible with a high degree of reliability to calculate how many times within, say, a ten-year period a given collective farm would have frosts before or after the normal dates, to what extent various parts of the farm are supplied with heat, how often a given plant will grow to maturity and so forth.

Despite the obvious importance of climate for agriculture, the use of climatic data for specific agronomic purposes has always involved great difficulties unlike, for example, the use of soil surveys. The outstanding British meteorologist Sir Napier Shaw wrote with a full knowledge of the situation: "Everyone agrees that crop cultivation depends on the weather, but finding ways by which the meteorologist's figures can be used in practice by the cultivator is a task whose solution requires something approaching genius." It seems to us that this difficult problem is being solved by Soviet science. It has worked out relatively simple methods that permit the utilization of accumulated meteorological data for the proper organization of agricultural production.

Climates are also being studied from a specialized viewpoint for the benefit of public health in the broad sense, the hygiene of clothes and for increasing labor productivity in outdoor work. These studies have developed to the extent that a separate discipline -- medical climatology -- has been formed. One of the main objectives of this field of study is to provide climatic justification for the location of resorts and spas, to determine their characteristics and to establish schedules for the use of the medicinal waters, whose resources depend on precipitation. The Soviet Union now has about 450 resorts under various climatic conditions, including 255 purely climatic resorts. Medical people feel that, with rare exceptions, any resort, whether balneological or mud-baths resort, is also a climatic resort. Moreover they quite properly maintain that various forms of climate therapy can also be used in rest homes and even in ordinary country houses.

Climatology is used to determine the zones within which the therapeutic factors of a given resort must be protected and to plan the distribution of sanatoriums, of climate-therapy grounds and of the planting of greenery to regulate heat, moisture, winds and to combat air pollution. This requires special microclimatic studies, for which methods have now been sufficiently developed.

Clothes adopted to local climatic conditions are of tremendous importance to maintain a high degree of work capacity while insuring physical well-being, expanding the zone of comfort and protecting people against disease. Clothing types and styles corresponding to local conditions have been worked out in areas where a native population has been living for centuries. In most cases these rational clothing styles reflect the ecological relationships between man and his environment. For example, in the severe climatic conditions of the Far North, comfort is insured through the scientific use of warm clothing and footwear of light weight and minimal bulk based on the Chukchi's use of reindeer skin lined with fur inside and outside. In the hot areas of Central Asia the high radiational heating of body surfaces has led to the development of a type of clothing that protects the head against direct rays of the sun, insulates the foot from the superheated ground and reduces the body's loss of moisture by preserving the salt-water and heat balance of the human organism.

Light industry is constantly designing improved materials for clothing and footwear. The centuries-old traditions are therefore inadequate even for aboriginal populations. In addition, formerly uninhabited areas are now being settled on an ever growing scale and large masses of people are being moved from one area to another. Under these conditions it has become necessary to establish clothing types and styles based on scientific principles, taking account of the qualitative relationships between climatic factors, such as the equivalent-effective temperature, and of the adaptability of the organism to climatic conditions. Serious scientific studies are just starting in that field and are undoubtedly of considerable promise.

Special working conditions must be provided in extreme cold or heat to increase labor productivity. Outdoor work in very cold weather tends to reduce labor productivity and leads to illness and loss of working time. On the other hand, meteorologically unjustified work stoppages result in production losses. The following procedure has been adopted in Magadan Oblast:

(a) Outdoor work (except for emergency and rescue operations) is halted at temperatures of -50° C and lower, or at temperatures of -36° C and lower combined with a wind velocity of more than 7 meters per second;

(b) Hourly warm-up work breaks of 10 minutes are provided at temperatures from -21° to -34°, and 15 minutes at temperatures from -35° to -49°. This means that the average number of nonworking days during the cold season is up to thirty, and 150 to 180 days with additional warm-up breaks have an average of 6 to 7 working hours (N. K. Klyukin, 1960).

Institutions concerned with city planning and the designing of urban buildings make heavy use of climatic data, both general and specialized. Climatic factors are so important in city planning that they are now taken into account by the official publication Stroitel'nyye normy i pravila (Construction Standards and Rules). The special term "construction climatology" is entering into use.

Special attention must be given to the microclimate of a prospective urban site. Improper siting may lead to poor ventilation and stagnating air in summer and to excessive cooling in winter, to excessive snow drifting, increases in fogginess and so forth. Of considerable significance is the correct orientation of streets with respect to the direction of prevailing winds. The street orientation should vary according to climatic conditions. In warm areas it should promote good ventilation, and in northern areas it should provide protection against cold winds. The orientation of streets also affects the natural lighting of a city and the heating of buildings by the sun, with different factors entering into play in the north and in the south.

Residential and industrial areas must be correctly placed with respect to each other. If prevailing winds are ignored, smoke and industrial fumes would be carried toward the residential area.

Building designers use several specialized climatic indices. These climatic characteristics must be taken into account in:

(1) establishing standards for the designing of the supporting structural elements of a building that is expected to withstand given wind velocities and snow loads;
(2) providing heating installations for buildings;
(3) calculating ventilation and heating requirements.

The designers require only simple climatic data, such as the prevailing wind velocity or the height and density of the snow cover, for the design of supporting structures. But for the calculation of heating and ventilation requirements, they need specialized climatic indices, such as the length of the heating season, its average temperature, and the so-called calculated temperatures used for winter ventilation and heating.

The Climatology Section of the Main Geophysical Observatory has worked out special methods for determining these magnitudes and has also delimited relevant regions in the USSR.

Climatic factors must also be taken into account in the designing of types of residential housing. However, the climatic regionalization worked out for that purpose by the Housing Institute should not be taken as the final word in that field and needs further improvement.

The use of climatology in overland transportation and aviation coincides in part with its applications in construction (construction of railroad stations

and lines) and in communications since both applications are closely linked with railroad operations. However, there are some special aspects in transportation applications. In the case of overland transportation, there is need for maintaining the right of way in fluctuating temperatures (freezing and thawing of the ground), the problem of protecting the right of way against snow and dust drifts and against washouts by downpours and meltage water; river transportation depends on information about precipitation, which in the final analysis determines the river levels; and water transportation as a whole requires information on temperatures and winds to estimate the times of freeze-up and thaw of water bodies and ice movements in the transition periods. Winds affecting the level and waviness of water bodies are important for the design of harbors. All types of transportation are interested in extreme temperature fluctuations (if only for purposes of fuel consumption), strong winds, and especially visibility (in aviation, also cloudiness), as well as actually dangerous phenomena, such as the icing of airplanes and glaze.

A distinctive characteristic of transportation is that it moves along specified routes, sometimes for long distances, and any obstacle along that route may hold up all movement. In the case of long routes, even phenomena that occur rarely at any given point may result in frequent stoppages along the route as a whole. A program for combating snow drifts, for example, requires data on the extent to which large sections of the route are affected by snow storms and to what extent these are storms of long duration. The snow-fighting tactics would change accordingly. The solution of problems such as these requires data on distribution of harmful phenomena both in time and in space. General climatic data used for transportation purposes have been accumulated in rather large amounts, but specialized data adapted specifically to the needs of overland transportation and aviation require additional development. Of special importance for aviation are the climatic characteristics of airports because airplanes encounter most of their meteorological problems in landing and take-off.

Climatic data have been widely used in recent years to analyze ice conditions in seas and oceans and to study waves and ocean currents. The operations of deep-sea fisheries and ocean transportation depend to a considerable degree on hydrophysical processes, which in turn are affected by climatic conditions.

Prospects of further development of climatic resources. Much remains to be done in developing climatic resources for economic purposes. Several agricultural zones of the Soviet Union have tremendous reserves of unused heat and moisture. After the harvest of winter and early spring grains in areas of sufficient moisture in the forest-steppe of the Ukraine, the Belorussian SSR, the Northern Caucasus, the Central Chernozem oblasts and parts of the non-chernozem belt, sums of temperatures over 10° ranging from 1,000 to more than 2,000° and amounts of water ranging from 1,000 to 2,000 cubic meters per hectare remain unused during the growing season. This represents 40 to 60 per cent of the available resources of biologically

active heat and a somewhat smaller percentage of the water spent in transpiration.

After the main crop has been harvested, the heat and water available during the rest of the growing season could be used for a second harvest by intercropping. Several leading collective farms in the above-named areas are already following that practice. The intercropping may yield 20 to 30 tons of green corn and other forage crops per hectare. According to preliminary estimates, several million hectares in the Soviet Union could yield two crops a year. In areas of sufficient moisture and in wet years, the use of fallow land under crops could also yield hundreds of millions of poods of additional grain and animal feeds.

The full utilization of mutually compensating climatic conditions of the nation's farm lands is of great importance for insuring a stable grain harvest from year to year. Most of the vegetable proteins, carbohydrates, oils, alcaloids and animal products are obtained in the Soviet Union, as elsewhere in the world, in the moisture-deficient zone. In many respects it is more favorable to agriculture than the other physical-geographic zones. However, the arid areas are periodically affected by drought, resulting in the loss of hundreds of millions of poods of grain annually.

Droughts usually affect extensive territories. But they do not affect the entire zone of insufficient or unreliable moisture conditions. Only parts of that zone are affected by droughts. Moreover the drought-affected area within the zone may vary from year to year. In addition, as a result of the circulatory characteristics of the atmosphere, the drought-affected area always borders on an area where precipitation exceeds the norm. The surplus precipitation may sometimes amount to two or three times the norm. More rarely precipitation may amount to five or six times the norm. The harvest losses in drought-affected areas are therefore compensated by unusually good harvests in adjoining areas. In the last 62 years, for example, drought occurred 26 times in the Ukraine and 29 times in Orenburg Oblast. But drought occurred only on three occasions simultaneously in both areas (A. I. Rudenko, 1958). Similar, though less clearly expressed, mutually compensating conditions are observed in moisture-deficient parts of the Ukraine, the Volga valley and Kazakhstan. Of great economic importance, in this connection, is the further utilization of virgin and idle lands in Kazakhstan and Siberia, and the development of fertile soils in the Soviet Far East, particularly in the Amur and Ussuri valleys.

The Soviet Union has a variety of natural and climatic conditions unmatched anywhere else in the world. Moreover, these conditions in the Soviet Union change continuously within its huge territory, while they are discontinuous, for example, in the case of Britain and her colonies scattered over the world.

The principal crops and varieties have been regionalized by zones in accordance with changes in natural and climatic conditions. Many of these

crops have been distributed so as to make full use of the heat and moisture available through the entire growing season. There is ample scientific justification for such a distribution. The longer the growing season of a given plant, the greater is the organic matter that it can accumulate and the larger, as a rule, is its yield. Accordingly the crops with the latest dates of maturation are located in the south, while early crops and extremely quick-maturing crops are located farther north. In all zones these crops basically mature in autumn, thus providing fresh vegetables, fruits, berries and grapes for a period of one or two months a year. Agroclimatic calculations show that this period could be extended to 6 or 7 months with a change in the geographical distribution of crops.

The hottest areas should devote a certain percentage of their cropland to extremely quick-ripening crops and varieties, which would then mature in early June. Crops with a longer growing season, including the very latest crops, should then be distributed by areas so as to guarantee a supply of fresh farm products until the end of December. Fresh vegetables could be obtained even in winter in the subtropical areas of the Soviet Union. In view of the present stage of development of means of transportation, this would insure a year-round supply of fresh farm products to the nation's cities at a cost much lower than the cost of hothouse cultivation.

Two climatic resources that are still largely unused are wind and solar radiation. The energy of the wind is of tremendous magnitude. According to available estimates, it exceeds by several thousand times the total energy obtained annually from coal. Wind energy requires no transportation or transmission lines, and its reserves are inexhaustible. However, this type of energy also has its negative aspects. It cannot be accumulated to create large capacities, and it varies over time down to complete calm. Nevertheless there is no doubt that wind energy can be utilized. The Soviet Union has considerable experience in setting up wind-driven motors and electric-power stations ranging in capacity up to several hundred kilowatts. Wind motors can be effectively used in areas where the average annual wind velocity exceeds 4 meters per second, and wind-driven power stations would be justified in areas having an average wind velocity of more than 5 meters per second.

Large areas of the Far North have average winds of 6 to 9 meters per second. Winds of average velocities of 4 to 6 meters per second are found in a large part of European Russia, including the entire steppe zone, in the forest-steppe and steppe of Western Siberia, in northern Kazakhstan, the Kuznetsk Ala-Tau, the foothills of the Altay and the Western Sayans, and in many areas of Eastern Siberia and the Far East. Through this territory, areas remote from power transmission lines could be supplied by wind motors or power stations.

Wind can also be used for irrigation and water spreading in arid regions and deserts. Many of these areas have fresh groundwater supplies near the surface. In spite of these circumstances, wind energy, is used very little

in the Soviet Union. The total number of wind installations in the Soviet Union is less than 20,000, according to Ye. Fateyev, far fewer than the number of windmills in prerevolutionary Russia. As late as the 1930's, according to B. B. Kazhinskiy, the number of home-made wind motors amounted to 100,000. That number could now be increased by several times on the basis of modern production methods. There is no reason why Soviet technology, capable of concentrating tremendous power in a single site (the Kuybyshev, Bratsk and other hydroelectric stations, and the atomic power stations), should be unable to use a widely scattered energy source supplied by nature herself.

The utilization of the energy of the sun and the wind has much in common. The amount of solar energy reaching the surface of the earth is huge, but its density per unit area is very low. The concentration of large capacities therefore requires very large reflecting or collecting surfaces. Moreover solar energy varies in a 24-hour period and within a year as well as in accordance with weather conditions. This makes the construction of large solar energy installations uneconomical, even in the southern parts of the Soviet Union. The character of distribution of solar energy over the surface of the earth suggests the need for establishing small solar-energy installations. If sufficiently numerous, their total capacity could by many times exceed the capacities of a hundred large hydro-electric stations.

We now have installations that utilize solar energy to heat or cool homes, to heat, evaporate or distill water, to cook food, to dry fruits, to make salt by boiling, and so forth.

Solar energy can be converted into mechanical and electrical energy for use in various sectors of the economy that consist of numerous, widely scattered small production units. Such a sector is agriculture. In Central Asia and Kazakhstan, in the Caucasus, in the Crimea, in the Urals, in the lower Volga valley and in southern Siberia, all areas receiving the greatest amount of radiation in the Soviet Union, various economic sectors, and especially agriculture, could make effective use of the inexhaustible supply of solar radiation.

The Soviet Union is giving much attention to the conservation of natural resources. This also applies to climate. Geography is full of examples of how man's activities in many parts of the world have caused deserts to gain at the expense of the steppe, steppes to gain at the expense of the forest-steppe, fertile lands of the humid zone to be transformed into swamps, and so forth. But there are also opposite examples, especially in the Soviet Union and the other Socialist countries. The conservation of renewed natural resources, including climate, does not mean their preservation in untouched form. It means rather intensive utilization under the conditions that the maximal exploitation of nature does not exhaust but rather multiplies her resources.

With respect to climate, such conservation can be achieved by large-scale

reclamation measures, such as irrigation, water spreading, drainage, windbreak planting, fallowing of land, snow conservation and conservation of meltage water, and the use of differentiated agricultural techniques. Methods worked out in climatology make it possible to measure quantitatively the effect of each of these measures on a directed change of climate. The use of similar methods in other branches of physical geography would promote the most rational utilization of nature and not only conserve the resources that we have inherited, but enrich them for future generations.

SURFACE-WATER RESOURCES OF THE USSR: THEIR UTILIZATION AND STUDY

By S. L. Vendrov and G. P. Kalinin

(The concept of water resources includes, in addition to surface waters, also ground waters, glaciers and avalanches, as well as coastal sea and ocean waters. This report, therefore, discusses only part of the over-all problem of water resources.)

The study and utilization of natural surface waters are part of the over-all scientific and economic objective of the diverse and increasingly intensive utilization of resources and the transformation of nature. In hydrology, as in other branches of science concerned with the study of the geographic environment, there is a growing need not only for the integrated and complete utilization, but also for a conservationist attitude toward natural resources, even in areas where economic utilization is still far from being intensive and where the density of population is still low.

1. Surface-water resources and their distribution in the USSR.

Both the general geographic and the specialized hydrologic literature constantly emphasize the Soviet Union's wealth in surface waters. The total annual stream flow of the Soviet Union's rivers does in fact amount to the tremendous magnitude of 3900 cubic kilometers in an average year, which corresponds to a theoretical water-power potential of 3680 billion kilowatt-hours a year. The potential irrigated area based on that stream flow is about 4 million square kilometers, assuming an average irrigation layer of 1,000 mm.

The total length of Soviet rivers exceeds 3 million kilometers, and the length of shoreline of just the reservoirs is expected to exceed the length of the coasts of the Soviet inland seas by 1965. Most of the rivers (about 155,000) are found in the Asian part of the USSR, leaving 45,000 in the European part. The total number of lakes and reservoirs with an area of 0.1 square kilometers or more exceeds 330,000 square kilometers, of which 65,000 are artificial reservoirs. That number of lakes is likely to increase even further if counted on maps based on aerial surveys. Most of

the lakes are in the European part of the USSR (210,000) and in Western Siberia, due largely to the predominant lowland relief and the fact that these regions contain most of the artificial reservoirs.

The presence of huge water resources in the Soviet Union is one of the most important prerequisites for the development of the economy. Consequently the utilization and study of water resources should be increasingly broadened. However, while stressing the wealth of Soviet water resources, we should not ignore a number of factors important from the physical-geographic and economic-geographic viewpoints that complicate the utilization of the waters. These factors are the following:

1. The great continentality of climate in many parts of the country, resulting in a relatively limited stream flow compared with the world average per unit area. The USSR accounts for only 13 per cent of the world's total stream flow compared with a 16-per-cent share of the world's land area. The predominance of lowlands has brought about a relatively lower unit water-power potential, or 68 per cent of the world average. The USSR accounts for only 11.4 per cent of the world's total water-power potential, i.e., less than either the stream-flow and land-area share. Because of these factors, the Soviet Union has been forced to engage in widespread reclamation measures and to build large hydroelectric stations on rivers with low gradients on a scale unknown in other countries.

2. There is an extremely uneven distribution of runoff over the territory of the USSR. The greatest runoff occurs in mountain areas. For example, the runoff on the southwest slopes of the Caucasus is equivalent to a layer of 3600 mm a year. In the tundra, tayga and deciduous forests, runoff ranges from 450 to 100 mm a year: in the steppes from 100 to 20 mm, and in the deserts from 20 mm to zero. Surface-water supplies generally vary in inverse ratio to water needs.

Because of the unfavorable geographic distribution of surface waters over the USSR and the existing runoff conditions, about 45 per cent of the total Soviet territory, or 10 million square kilometers, require reclamation measures, including 8 million square kilometers of additional water supply and 2 million square kilometers of drainage (these figures exclude the tundra and wooded tundra). This situation accounts for the proposed projects of large-scale transfers of water from one river basin to another (from the Pechora to the Volga-Kama basin, from the Irtysh to northern Kazakhstan and the interior-drainage areas of Central Asia, and so forth).

3. Annual fluctuations in runoff greatly increase from north to south. In the northern part of the forest zone, for example, the stream-flow variability coefficient is 0.15 to 0.20, and at the border between the steppe and the desert 1.0 to 1.2. This makes necessary the long-term control of runoff in the southern parts of the USSR.

4. A large part of the territory of the USSR experiences sharp seasonal

fluctuations in water supply, with a marked maximum in spring runoff. The alternation of surplus and deficit water supply produces such "extremes" as, for example, the almost complete freeze-up in the Far East of rivers that have abundant stream flow in summertime, rendering them useless as a source of water in winter. Another example is the drying up of rivers in the Trans-Volga area and in northern Kazakhstan during their low-water stage.

To be sure, several parts of the country, notably the northwestern part of European Russia and Western Siberia, have a uniform distribution of stream flow through the year, with a relatively high low-water stage of long duration. But, in general, the relationship between low and high-water stages on most of the Soviet Union's rivers is far less favorable than on the rivers of Europe, North and South America, and eastern and southern Asia. This makes the problem of seasonal stream control an especially acute one in the Soviet Union.

5. A distinctive characteristic of the river network of the USSR is the dominant north-south alignment of most of the large rivers.

In the Asian part of the country the northward flow of the principal streams has in the past interfered with the development of Siberia and with the establishment of economic and cultural ties between the peoples of Eastern Europe and China. At a time when rivers were the most accessible means of communication within continents, the great Siberian streams were for the most part geographical obstacles rather than aids to communication. In the early stages of the conquest of Siberia, it was not the main rivers but their east-west-oriented tributaries that played the key role as means of transportation. In contrast to the unfavorable orientation of the main rivers of Siberia, the principal streams of the European part flow from areas of surplus moisture to areas of moisture deficits (for example, the Dniester, Southern Bug, Dnieper, Don, Volga and Ural).

The European rivers of the USSR account for 39 per cent of Europe's total stream flow (about 1000 out of 2560 cubic kilometers); the corresponding figures for the Asian part of the USSR are 42 per cent (about 3000 out of 7150 cubic kilometers).

From the point of view of water-power production, the water resources of any area are determined by a combination of stream flow and relief, which in effect determine the general and local gradients of river valleys and channels and the relationship between the total and usable volumes of lakes and reservoirs. In this sense the relief of a given area thus also becomes a natural resource. The importance of relief, together with the importance of stream flow, becomes especially clear when the percentage distribution of stream flow is correlated with the percentage distribution of the theoretical potential water-power resources calculated by the Gidroenergoproyekt (the hydroelectric designing agency) by the formula $P = 9.81QH$, where P is the potential, Q is the arithmetic mean of the average discharges, and H the difference in levels between the terminal sections of the stream profile (Table 1).

Table 1. Correlation of the distribution of stream flow and water-power potential over the Soviet Union

	Percentage distribution	
	of stream flow (Zaykov, 1946)	water-power potential (Voznesenskiy, 1957)
USSR as a whole	3938 cubic km. =100 per cent	340 million kw. =100 per cent
European part	33	18
Asian part	67	82
Drainage basins:		
Atlantic	8	6
Arctic	60	55
Pacific	22	12
Caspian, Aral and interior drainage	10	27

The absolute magnitude of the theoretical water-power potential must be qualified because the 340 million kw. (or 2978 billion kwhr.) were based on the 1477 relatively large streams of the USSR. The probable theoretical potential for the entire river network would be about 420 million kw. (or, as stated above, 3680 billion kwhr.).

The following rivers have the greatest water-power potential (Table 2):

Table 2. Water-power potential of main Soviet streams

River	Million Kilowatts	Billion Kilowatt-hours
Lena	18.36	161
Yenisey	18.21	160
Angara	9.88	86
Amur	6.43	56
Indigirka	6.20	54
Volga	6.20	54
Naryn	5.94	52
Pyandzh (Panj)	5.82	51
Ob'	5.74	50

The table shows at a glance to what extent the water resources are unevenly distributed throughout the country and how a large part is concentrated in uninhabited areas.

An even clearer idea of the lack of correlation between the territorial distribution of water, specifically water-power resources, on the one hand, and water needs and the degree of economic development of territories, on the other hand, is given by Table 3.

Table 3. Correlation of areas, population density and water-power resources by union republics

Union republic	Area (in percentage of the USSR)	Population (in percentage of the USSR)	Water-power potential (in percentage of the USSR)	Relative population density	Relative water-power potential per sq.km.	Relative water-power potential per person
USSR	22.27 million sq. km. =100	200.2 million persons =100	2978 billion kwhr. =100	9 persons per sq.km. =1.0	133.7 kwhr. =1.0	14.9 kwhr. =1.0
RSFSR	76.7	56.5	73.3	0.8	0.95	1.32
Ukraine	2.6	20.3	1.2	7.8	0.57	0.07
Belorussia	0.9	4.0	0.2	4.4	0.2	0.05
Uzbek	1.9	3.6	2.1	2.0	1.15	0.58
Kazakh	12.4	4.2	4.4	0.3	0.36	1.04
Georgia	0.3	2.0	3.3	5.9	9.55	1.49
Azerbaydzhan	0.4	1.7	1.1	4.4	2.9	0.67
Lithuania	0.3	1.4	0.1	4.7	0.44	0.10
Moldavia	0.2	1.4	0.1	8.8	0.71	0.07
Latvia	0.3	1.0	0.2	3.4	0.62	0.17
Kirgiz	0.9	1.0	4.5	1.1	5.15	4.70
Tadzhik	0.7	0.9	7.9	1.4	12.3	8.75
Armenia	0.1	0.8	0.5	5.9	3.63	0.63
Turkmen	2.1	0.7	0.8	0.3	0.37	1.10
Estonia	0.2	0.5	0.1	2.6	0.09	0.04

The table shows the existence of huge disproportions between water-power needs and the existing potential in various union republics. For example, the water-power potential per person in the Tadzhik SSR is 7 times greater than in the RSFSR, 125 times greater than in the Ukraine and 220 times greater than in Estonia.

2. The utilization of water resources.

The present status of the utilization of water resources by the main sectors of the national economy is shown in Table 4, which is based on published data and on data supplied by the Gidroenergoproyekt (hydro-electric designing agency) of the Ministry of Power-Station Construction, by TsNIIEVT (Central Scientific Research Institute of Waterways Operations) of the Ministry of the River Fleet, and by Giprovodkhoz (water-management designing agency) of the Ministry of Agriculture (November 1959).

Table 4. Utilization of Water Resources of the USSR

Basic Economic Sectors	Unit	1913	1940	1955	1958	1965 Plan*
Water Power						
Water-power output	billion kwhr.	0.04	5.1	23.1	46.5	100
Water-power share in total output	%	2.0	10.5	13.6	20.0	20.0
Navigation						
Length of all inland waterways	thousand km	64.6	107.3	132.0	133.4**	152
Length of canals	"	3.1	4.6	5.6	9.7**	15.1
Freight loadings	million tons	35.1	72.9	139.1	177.4	265
Freight traffic	billion ton-km	28.9	35.9	67.4	88.1	140
Reclamation						
Actual irrigated area	million ha	3.5	6.1	7.2	7.0	10.6
Drained area	million ha	2.8	6.0	8.2	8.4***	12.4

Notes: * The 1965 plan figures are approximate and provisional
** As of January 1, 1958
*** As of 1956

The table shows that water-power generation has made the greatest progress. Water-power output in 1958 was 115 times greater than in 1913 and 9 times greater than in 1940. The length of inland waterways in 1958 was twice as great as in 1913 and 25 per cent greater than in 1940. Freight loadings increased by 5 times and 2.4 times, respectively. Reclamation has been making slower progress.

Great changes are now taking place not only in the volume of water-power generation as a whole, but in its geographical distribution. The share of the eastern areas is increasing, and the disproportion in the geographical distribution of exploited water-power resources is lessening. This process is expected to continue in the following years.

A major role in liquidating the disproportions in water-power generation is played by the growth of long-distance power transmission lines. This development neutralizes to a certain extent the unfavorable consequences of the uneven distribution of stream flow by areas and by flow stages.

The eastern areas are also beginning to play a more important role in water transport. The share of the Asian river basins in the total river freight loadings of the RSFSR rose from 14.5 per cent in 1951 to 17.8 per cent in 1958 and is expected to rise to 23 per cent by 1965.

Reclamation is still lagging behind the requirements of the national economy. While most of the drained land is actually used by agriculture, there is still a large discrepancy between the land supplied with irrigation networks and the land actually irrigated (Table 5).

Table 5. Correlation between land prepared for irrigation and actual irrigated lands

	1940	1955	1957
Area prepared for irrigation (in million ha)	9.5	11.0	11.1
Actual irrigated area (in million ha)	6.1	7.2	7.0
Percentage of use	64	65.5	63

The gap between the total area prepared for irrigation and the area actually in use is due to several factors. They include secondary deposition of salts in the soil, as a result of which irrigated land becomes unfit for crops after several years. This phenomenon was typical in the past of irrigation in desert and semi-desert lands, and to a lesser extent in steppes. Another major factor in the non-use of potential irrigation is a shortage of manpower, especially in the desert and semi-desert zones.

It is no accident that the basic water-use sectors in Table 4 are limited to water power, navigation and reclamation. Unfortunately, a major water-use sector such as water supply is still little developed in the USSR, which is especially evident against the background of Soviet achievements in other water-use fields. (This paper does not cover such water-use problems as fisheries, forest conservation and others.) Until recently we have had only one case in which the question of water supply for a major city and industrial area was solved through radical reconstruction of the surface waters. That was the transfer of Volga water to Moscow through construction of the Moscow-Volga Canal. The situation is now gradually changing.

Elimination of the lag both in irrigation and in the water supply of the country's arid areas is being aided by the recent growth of large water-control projects. They are the canals Northern Donets-Donbas, Dnieper-Krivoy Rog, Irtysh-Karaganda, Amu-Darya -- Kara-Kum, and the irrigation systems of the northern Crimea, the Northern Caucasus, the Trans-Don lands, the Trans-Volga lands, and the Golodnaya Step' (Hungry Steppe) on the Kazakh-Uzbek border.

The list, in which canals for the long-distance movement of large masses of water play a key role, clearly shows that a start is being made in insuring the water supply of southern industrial areas and in moving irrigation projects in part from the desert and semi-desert into the steppe. Moreover, irrigation projects are now concerned with stream-flow regulation and not merely with the transfer of water to cropped areas. It should be stressed in this connection that the USSR is making little use of ground water for such purposes. North Africa and other foreign arid areas have been relying to a considerable extent on ground water for irrigation and water-supply needs. As for the Soviet Union, it seems that the Kara Kum desert has favorable conditions for the utilization of artesian wells and ground water from upper horizons that could be replenished artificially with surface water.

The construction of canals for water supply and irrigation supplements the great hydroelectric centers that have been built or are under construction on the Volga, the Kama, the Dnieper, the Don, the rivers of the Northwest and West, the Irtysh and the Ob', the Angara and the Yenisey, and in the future on the Amur and other rivers.

The seven-year plan 1959-65 calls for completion of the construction of a deep-water Volga-Baltic waterway, which will replace the antiquated Mariinsk system, no longer adequate for modern water transportation needs. The construction of the Volga-Baltic waterway will complete the unified system of inland waterways of European Russia, which includes the following key links: the Canal named for Moscow (the former Moscow-Volga Canal), the White Sea-Baltic waterway and the Volga-Don Canal. The reconstruction of the Dnieper-Bug waterway, though of smaller size than the other waterways, would promote inland water transportation links with Poland, East Germany and other countries.

The use of rivers for navigation underscores the need for prompt cessation of log-floating practices on the rivers of northern European Russia and of Siberia. The floating of logs downstream stimulates channel-forming processes, "spoils" rivers for use as waterways and irrigation and water-supply sources, worsens the chemical and biological qualities of surface waters,and noticeably increases the amount of humic acids in rivers. Logs should henceforth be moved in the form of rafts or on ships.

The construction of hydroelectric nodes on plains rivers has resulted in larger ratios between the total storage capacity and the usable capacity of several major reservoirs. Let us take the hydro stations of the Volga-Kama system as an example. Upon completion of all 13 stations (nine on the Volga and four on the Kama), the total reservoir area will be 37,600 square kilometers, the total storage capacity 288 cubic kilometers, and their usable capacity 90 cubic kilometers, or only 31 per cent of the total. In other countries, for example, in the United States, the ratio of usable to total capacity may be twice as large.

By 1965 the total area of reservoirs in the USSR is expected to be 50,000 square kilometers, the total storage capacity 530 cubic kilometers, and the usable capacity 230 cubic kilometers. This calculation does not include natural reservoirs, such as Lake Baykal (for the Irkutsk Hydro Station) and Lake Onega (for the Upper Svir Hydro Station). The usable capacity ratio is expected to improve with the construction of reservoirs on the Angara and Yenisey rivers, as well as the Bukhtarma reservoir on the Irtysh.

The relative width of the large artificial reservoirs (per unit area) is almost a third of the relative width of the large natural lakes, pointing to the commonly elongated form of man-made reservoirs. The relative area of flooding (per meter of water head) for such large reservoirs as Rybinsk and Kuybyshev is 200 to 250 square kilometers. The average for plains reservoirs is 95 square kilometers, and for foothill reservoirs 30 square kilometers. The head of water at the dam ranges from11-36 meters in plains to 65-102 meters in the Mingechaur, Bukhtarma, Bratsk and Krasnoyarsk reservoirs.

One of the main tasks in future hydroelectric projects is increasing utilization of mountain streams and reduction of any further flooding, as well as rationalization of present flooding, of lowland areas with a relatively high population density.

Many multi-purpose water-control projects are not being used for all intended needs. The 1959 conference on multi-purpose use of the Kama Reservoir in Perm' noted in its resolution that funds allocated in cost estimates to agricultural purposes had not been used; it was also noted that agriculture had not been fully compensated for a lowering in soil fertility and for deterioration in local overland transportation. The same reservations can be applied to other large reservoirs. For example, the filling of the Tsimlyansk Reservoir flooded more than 2,000 square kilometers of fertile Don floodplain, but the compensating provision for irrigation water from the reservoir is being implemented very slowly.

In several cases Soviet government agencies have rejected plans for the construction of hydro projects that would cover floodplains in parts of the country where such lands are especially valuable. That was the case in a series of projects on the Oka River that would have affected the fodder supply and vegetable gardening of the Moscow region. There still is no agreement on the dam site of the Lower Kama hydro project, largely because planners are seeking a location that would have a minimal effect on the fodder supply of Tataria, already reduced by the flooding of the Kuybyshev Reservoir.

It is a mistake to try to reduce the costs of hydro projects by neglecting the preservation of the natural resources of floodplains and adjacent areas. Better use should be made of the shallow margins of large reservoirs, which could be used for high-quality fodder supplies and fish hatcheries.

The practice of maintaining the high-water surface of a reservoir above the planned normal level, while very effective for power generation, must be accompanied by additional measures designed to protect the shoreline and shore structures against additional wave erosion and flooding.

The scientific community should also have its say in the campaign against pollution of open water areas (and ground waters) by industrial and municipal wastes. That problem, which is now being felt acutely in several highly industrialized countries, must soon be solved in the Soviet Union. Examples of pollution can be found in the Kama Reservoir, the Kama and Belaya Rivers, and to a large extent in the Volga and other rivers. The most harmful pollutants are chlorides and sulfates. It is time that we start treating waste waters not only to avoid pollution but to obtain an additional source of higher farm yields.

One of the principal objectives of hydrology is the compilation of a water-resource survey of the USSR, listing the number, quality and location of the country's water resources and the current water consumption by regions. This huge project will require several years and a great deal of serious organization. However, only such a survey will make it possible to draft the unified scientific water-management plan needed to insure proper management of the Soviet Union's water resources and to prevent the reckless and thoughtless utilization of such resources.

The resolutions of this congress should note that the multi-purpose utilization of the country's water resources must be accompanied by a conservationist attitude toward other resources, particularly land, which in many cases is a valuable natural resource yielding material goods and is not merely a place for a construction site or population center.

3. The study of water resources.

The level of our knowledge of the natural laws that determine the regime of waters of the world's land areas affects to a considerable degree the character of the utilization of water resources and its economical effectiveness. The realization of water-control projects, the operation of completed structures and the transformation of the regime of waters in the Soviet Union are evidence of the strong development of the geographic sciences, which have supplied these projects with the necessary basic data and forecasting methods. This does not mean that hydrology's progress has been entirely smooth or that the forecasting methods in use at the present time have no defects, resulting in inadequate utilization of the potentialities of water management.

Russian scientists made a major contribution by posing the problem of the study and management of water resources, based on a qualitative analysis of the processes of formation of river regimes. The discovery by A. I. Voyeykov, D. I. Dokuchayev and V. R Vil'yams of the natural laws explaining the causation of river regimes by a combination of physical-geographic

factors created the prerequisites for the establishment of zonality in the distribution of runoff and for its study as one of the basic elements of the water balance of land areas. Ye. N. Dolgov's deep and purposeful studies served as a model for the organization of observations at stream-flow stations.

Lenin's emphasis on electrification soon after the Bolshevik Revolution required a thorough study of water resources and the organization of the State Hydrologic Institute, which became the guiding center in the creation of hydrology as a science. Later on, the accumulation of data and the development of theory were promoted by studies of the Hydrometeorological Service and of the planning and exploratory agencies and the institutions of the Academy of Sciences. These studies were coordinated by three hydrologic congresses (1924, 1928, and 1957) and by many conferences.

One of the conditions for the further development of hydrology and its calculations and forecasts is the possibility of directly measuring elements of river regimes at a network of observation stations rationally distributed over a given territory. It is quite obvious, however, that it is impossible to establish the huge number of direct-observation stations required by the growing needs of the national economy. If economic plans were to depend on the establishment of such a network of stations and the collecting of data over a period of many years, the construction of many hydro projects would have been put off for several years and the cost of such observations would have exceeded rational bounds. Therefore the Soviet network of stations consists of a basic network of observation points following a standard program as well as hydrometeorological observation stations and special-purpose stations studying river regimes under typical physical-geographic conditions at the level of entire river basins, of large features and elementary areas. Generalization, interpolation and analysis of the observation data then makes it possible to obtain a hydrological appraisal of water features despite the inadequacy or even total absence of observations on these specific features. The station network in the USSR is being developed according to a long-term plan taking account of the physical-geographic characteristics of individual areas and the present status and future prospects of development of water resources.

We should note at this point the important work being done by the Hydrometeorological Service of the USSR in carrying out its water-resource survey and the systematic publication of yearbooks containing basic hydrologic data.

An ideal solution that would fully meet all needs of the national economy would be the forecasting of the trend of hydrologic fluctuations and changes over a long-term period. However, we are still unable to make such forecasts because we cannot predict the long-term trend of meteorological elements. In addition to geographic and physical methods, estimates of future runoff fluctuations make wide use of the theory of probability. The combination of geographic, physical and statistical analytic methods makes it possible to obtain a picture of future runoff magnitudes that can be

used in the planning of water-management projects. It should be pointed out, however, that in many cases too much weight is given to the purely statistical approach and too little to geographic and genetic analysis.

Man's activities in several river basins have substantially altered the water and ice regimes of rivers. In many basins the future prospects of such changes must also be taken into account. The effect of large river-control projects on stream-flow changes can be determined by simple calculations. More complex is the calculation of the effect of small structures whose operations cannot be adequately controlled and the effect of agricultural measures. Such calculations must be based on approximate estimates derived from special studies and field work. Care must be taken in applying the experience gained from estimating the effect of agricultural measures in a given area to another area because the conditions of runoff formation and the effect of agricultural techniques may be quite different. In arid areas, for example, water collected by farm techniques on the surface of the soil is removed almost entirely from the runoff. In zones of excess moisture, on the other hand, increases in the surface collection of water may not have any substantial effect on the runoff. In view of the close link between the surface-water regime and the entire complex of geographic and economic conditions, care must be taken in applying runoff calculations to areas with different natural conditions and a different level of economic exploitation.

One of the central problems of physical geography in the field of hydrology is the determination of the effect of zonal and local geographic factors on the hydrologic regime. The solution of that problem is complex because of the diversity of natural conditions and their varying influence on individual hydrologic phenomena. Zonality does not by any means have a clear influence on all hydrologic phenomena; in many cases zonal factors are overshadowed by local factors. Zonality factors are most evident whenever hydrologic characteristics are generalized over time and in space. For example, in the case of basins with areas of several thousand or even several tens of thousands of square kilometers, zonal characteristics are quite evident in the distribution of the mean annual and the mean spring runoff. If we examine the average runoff in moderately large b asins, situated in several zones, zonal differences tend to disappear. On the other hand, when the basin area is further reduced, a substantial role is played by local runoff factors, such as lack of agreement between surface watersheds and underground watersheds, difference in soils and vegetation, and so forth. Finally, if we consider the runoff in very small areas, local factors become decisive and zonal characteristics can be distinguished only with difficulty.

The joint study of hydrologic characteristics and of elements of the water and heat balance provides excellent prospects for determining the physical causes that produce zonality and for improving methods of evaluation.

It is more complicated to determine the zonal factors affecting hydrologic phenomena over short periods because in those cases the growing role of

local factors often overshadows the role of zonal factors. There is an especially acute need for further development of the theory of formation of the regime of surface waters and for generalizations based on an analysis of new experimental data and a critical review of previous conclusions. In addition we must continue to use long-term average data, without which we cannot compare or determine the dynamics of the hydrologic regime. Hydrology has achieved quite a bit in that field, for example, in the study of maximum flow and of the variability of flow.

In order to evaluate the present status of the study and the future prospects of study of water resources, we must have a clear idea of the present trends of development of hydrologic studies. These trends are as follows:

1. Hydrology, like other sciences, is broken down into several specialized disciplines such as hydrography, hydrologic calculations, hydrologic forecasts, the dynamics of river channels, hydrochemistry, hydrobiology, hydrometry, and so forth. There is also a growing need for closer contacts between hydrology and adjoining branches of knowledge. New disciplines, such as agricultural hydrology, water-management calculations and hydrometeorology, have appeared on the borderline. Specific characteristics are also becoming evident in the field of transportation hydrology. There is also evidence of increasingly close contacts between hydrology and geomorphology. This increasing differentiation of hydrology does not mean increasing isolation. On the contrary, hydrologic studies must now emerge from the narrow framework of studying only water resources and some meteorological elements. The problem of the general study of the water and heat balance is gradually expanding into the problem of the study of a single water and energy balance of the earth's surface. This will tend to join closely all research in the vast field of geographic and hydrophysical disciplines and make it increasingly necessary to introduce all natural and human factors into the analysis of hydrologic phenomena.

2. The principal research concept in recent years has been a desire to determine under concrete physical-geographic conditions the natural laws of change of elementary hydrologic processes as the area of the catchment basin and the length of the hydrographic network increase. This is a much more complicated problem than merely the analysis of large series of numbers and the determination of the statistical laws of distribution. But this is the only way of radically improving hydrologic information required by the economy. This approach will greatly increase the importance of experimentation in hydrology. But these experiments would have to proceed on a higher level than previously. We have to reach the point where we will dispose of all the scientific data necessary to improve the level of scientific prediction and the day-to-day servicing of the economy.

3. It is evident from the foregoing that we must increase and improve the network of observation points without greatly increasing the cost involved. There is only one way of doing this -- a complete automation of observations and their transmission to processing centers. Such a re-

construction of the system should be accompanied by an expansion of the range of collected and transmitted data and should be designed to determine all basic elements of the water and heat balance within basins of various sizes over short time intervals.

4. Not so long ago the volume of hydrologic data was still quite limited; now it is growing rapidly and will continue to grow rapidly with increasing demand. The need therefore arises to mechanize the processing of hydrologic data. Such mechanization should of course make use of modern techniques. We should accumulate a supply of punch cards for the analysis of interrelations between various factors, for the construction of geographic maps and for the generalization of hydrologic data.

5. Finally, the basic trends of development of hydrology as a science also include a changeover from passive registration to an active campaign for maintenance and renewal of a high quality of surface waters and for a utilization of water resources that would be accompanied by an active defense of natural resources against reckless utilization.

In conclusion we would like to make a few comments about the training of hydrologists. The five years of study that are now required at the college level seem to be adequate preparation. But a student now beginning his course of studies will have to work independently in his special field under conditions of technical advances and a higher theoretical level than at the present time. It will become increasingly evident that the problem of the most effective utilization of water resources cannot be solved simply by using the standard methods of engineering computations. The program of full-fledged training of a hydrologist, like that of a natural scientist in any other field, will become more complex. A hydrologist-geographer is expected to be thoroughly familiar with the entire complex of natural processes that determine the hydrologic regime of a given area. At the same time he must have at his command a whole series of physical-mathematical and experimental methods, he must be familiar with the theory of probability, and he must know the principles of automatic data processing and the programming of electronic computers. At the same time he must be trained in the principles of hydrochemistry, water engineering and so forth.

The trends discussed above point up the urgency of improving the training of hydrologists. The further development of hydrologic studies and advances in water utilization will depend on the system of training. This system will also determine the course of the activities of future young scientists and production workers, for whom we, the present specialists in the water-resource field, are to a large degree responsible.

Literature

Bliznyak, Ye. V., and V. G. Andrianov. "Studies of lakes and man-made reservoirs of the USSR," Trudy III Vsesoyuzn. gidrol. s"yezda (Proceedings of the Third All-Union Hydrologic Congress), Vol. I, Gidrometeoizdat, 1958.

Budyko, M. I., and O. A. Drozdov. "Climatic factors of the water balance," Tr. III Vsesoyuzn. gidrol. s"yezda, Vol. I, Gidrometeoizdat, 1958.
Vendrov, S. L. "On the scale of the transformation of nature by large man-made reservoirs," Izv. VGO, Vol. 91, 1959.
Vendrov, S. L. Problemy ruslovogo rezhima bol'shikh vodokhranilishch na ravninnykh rekakh (Problems of the Channel Regime of Large Reservoirs on Plains Streams). Moscow University, 1959.
Vodokhozyaystvennyy kadastr SSSR; metodika sostavleniya (The Water-Management Survey of the USSR; Methods of Compilation), Ye. V. Bliznyak, editor. Publishing House of the Academy of Sciences USSR, 1956.
Voznesenskiy, A. N. "The water-power resources of the USSR and their prospects of development," Tr. III vsesoyuzn. gidrol. s"yezda, Vol.I, Gidrometeoizdat, 1958.
Gerasimov, I. P. "The problem of the water and heat balance of the earth's surface and its importance for physical geography," Tr. III vsesoyuzn. gidrol. s"yezda, Vol. I, Gidrometeoizdat, 1958.
Gil'denblat, Ya. D. "The influence of the Volga series of reservoirs on the high-water stage," Tr. III vsesoyuzn. gidrol. s"yezda, Vol. VI, Gidrometeoizdat, 1959.
Zaykov, B. D. Sredniy stok i yego raspredeleniye v godu na territorii SSSR (The Average Runoff and Its Distribution Through the Year Over the Territory of the USSR), Gidrometeoizdat, 1946.
Zvonkov, V. V. Kompleksnoye ispol'zovaniye vodnykh resursov v rechnykh basseynakh SSSR (The Multi-Purpose Use of Water Resources in the River Basins of the USSR), Academy of Sciences USSR, 1957.
Kalinin, G. P. "The present status and the future prospects of development of hydrologic forecasts," Tr. III vsesoyuzn. gidrol. s"yezda, Vol. I, Gidrometeoizdat, 1958.
Klitskiy, S. N., M. F. Menkel' and A. I. Chebotarev. "Water-management projects in the USSR and the contributions of hydrology," Tr. III vsesoyuzn. s"yezda, Vol. I, Gidrometeoizdat, 1958.
Narodnoye khozyaystvo SSSR (The National Economy of the USSR), statistical handbook, Gosstatizdat, 1956; same for 1958.
Osnovnyye napravleniya nauchnykh issledovaniy v oblasti kompleksnogo ispol'zovaniya vodnykh resursov SSSR v period 1959-65 (The Basic Trends in Scientific Studies of Multi-Purpose Utilization of the Water Resources of the USSR During 1959-65). Council on Water-Management Problems of the Academy of Sciences USSR, 1959.
Resheniye nauchno-tekhnicheskogo soveshchaniya po voprosam kompleksnoy ekspluatatsii Kamskogo vodokhranilishcha (Resolution of the Scientific-Technical Conference on Questions of the Multi-Purpose Utilization of the Kama Reservoir), Perm', 1959.
Sokolovskiy, D. L. "Runoff studies and calculations in the USSR, their present status and prospects of development," Tr. III vsesoyuzn. gidrol. s"yezda, Vol. I, Gidrometeoizdat, 1958.
Lvovitch, M. I. Hydrology and Utilization of Water Power, Moscow, 1955 (paper read at the International Geography Seminar, Aligarh, India).

(Additional papers from the Symposium on Natural Resources will appear in the next issue of Soviet Geography. Following is the first paper from the Symposium on Economic Regionalization.)

CURRENT PROBLEMS IN THE ECONOMIC REGIONALIZATION OF THE USSR

By Yu. G. Saushkin and T. M. Kalashnikova

The economic regionalization of the USSR should serve as one of the principal tools for the rational territorial organization of the country's productive forces and for establishing the most effective territorial division of labor within the country and on an international level. An economic regionalization of the USSR that properly reflects the objective reality of the territorial complexes of productive forces and their prospects of development would help to achieve the highest productivity of social labor possible at the present time.

Capitalism is unsuited to the broad regional method of territorial organization of the productive forces. In the peaceful economic competition between the Socialist and capitalist systems of production, regionalization therefore becomes of great importance as one of the ways of achieving maximum productivity of social labor.

The work on a general economic regionalization of the Soviet Union, now carried on by several groups, must be based on the general economic plans for the next 15 to 20 years.

Until now economic plans have generally been based on the time limit set for realization of the basic economic objective of the USSR. That objective is to reach and surpass the most developed capitalist countries in the per capita level of production of basic industrial and agricultural commodities. The current seven-year plan represents a major step toward realization of that objective. Consequently we face the problem of determining a new basic economic objective of the USSR for the next 15 to 20 years in terms of concrete economic indices reflecting the rate of development now achieved in the USSR.

The determination of the new economic objective of the USSR can no longer be based merely on the country's domestic needs. It must be related to the economic needs of the entire Socialist camp and to the economic role that the Soviet Union is bound to play in the Socialist camp and in the world as a whole.

The economic regionalization of the USSR for the next 15 to 20 years thus represents the formulation of the first variant of a hypothesis of development and territorial organization of the country's productive forces on a regional basis. When we speak of productive forces, we have in mind the future population of the country, its mechanical and energy supply, new

technology, new forms of transportation and the expanding utilization of old and new natural resources, particularly energy resources.

The economic regions of the USSR are the largest territorial complexes of productive forces. They are not simply statistical accounting units or "part of the country's national economy" (even if a "geographically integrated" and "territorial" part, as P. M. Alampiyev writes in his book Ekonomicheskoye rayonirovaniye SSSR (Economic Regionalization of the USSR), Moscow, 1959, p. 11), but territories with definite, actually existing (or prospective) complexes of productive forces. Some authors hold that "the essence of economic regionalization and of the economic region lies in the field of economic phenomena, in the field of productive relationships closely linked with productive forces..." (P. M. Alampiyev, op. cit., p. 11). No one denies that the development of economic regions follows the laws of society, but a regionalization of the USSR must be based not on territorial differences in productive relationships but on differences in the territorial complexes of productive forces. Thus it is not the productive relationships but the productive forces that are the object of regionalization. A region cannot be delimited without reference to a concrete territory and its natural resources and natural conditions of production, including its lands, its population and its existing material riches, i.e., whatever its productive forces have created.

The idea of delimiting a region as a territory with a definite productive complex (a complex of productive forces), having good prospects of development and occupying a definite place in the general economic dynamics of the country, was reflected in the work of the Kalinin Commission, the Gosplan or State Planning Commission (G. M. Krzhizhanovskiy, I. G. Aleksandrov and others), N. N. Kolosovskiy and other Soviet study groups and individual scholars.

One of the basic requirements for the economic regionalization of the USSR is the precise modern definition of "economic region." Such a definition was supplied in the studies of the Kalinin Commission, the Gosplan of the 1920's, the studies of I. G. Aleksandrov and other scholars. That definition is one of the greatest discoveries of Soviet science. The definition of an economic region given by the Gosplan in the early 1920's has withstood the test of time. It might be said that the question is settled and there is no point in reopening it. The question is in fact settled, but there is a point in reopening it because there is a growing number of people who are trying to reject the old Gosplan definition of an economic region. Attempts to abandon the methodology of regionalization approved in the early 1920's by Lenin are justified by some comrades by the fact that forty years have passed, that the country's productive forces have greatly grown, that the social system of the USSR has developed and the construction of a Communist society has begun, that the technology of production has greatly changed, new natural resources have been discovered, the place of the USSR in the international division of labor has changed, and so forth. Certainly, great social and economic changes have taken place in the Soviet Union in the last forty years and have left their imprint on the economic regionalization of the country. But the comrades who are trying to discard the methodology

of regionalization worked out in the 1920's should first prove scientifically and demonstrate concretely how and why the old principles of the Gosplan methodology of economic regionalization have become outdated. They should justify, in particular, the replacement of the Gosplan regions of the 1920's with the smaller oblasts of the 1930's, and the establishment of the 13-region system of the 1940's; they should explain why the economic regions of the 1920's first disappeared and were then transformed into the 13 larger regions of the 1940's. So far no one has attempted to justify these changes. (A map of the 13 regions appears on the opposite page).

The point is that Gosplan in the 1920's defined the basic regions of productive forces. These regions either existed already objectively or promised to emerge in the future. An attempt was made to make these basic regions coincide with the superstructure of administrative-political divisions, also based on economic considerations. This agreement between the two types of divisions was violated in the 1930's in connection with the formulation of new political objectives, but the regional complexes delimited in the 1920's continued to exist and to develop regardless of the new administrative division of the country. The 13-region breakdown of the Soviet Union, adopted in 1940 for statistical-economic accounting purposes, does not represent a regionalization of productive forces reflecting actually existing major territorial complexes. Again, these complexes continued to exist independently of the 13-region breakdown.

In other words, since the end of the 1920's we have had no generally accepted scientific regionalization of productive forces that could be used as the basis for planning the territorial organization of the country's productive forces. This situation has hampered and continues to hamper the planned development of the Soviet Union. On the basis of such a scientific regionalization of productive forces we could then establish the various superstructural categories, such as administrative-political units, statistical-accounting units and other territorial units, needed for various purposes. But it is quite wrong to pass off these superstructual units as the actual basis, in place of regions of productive forces, as is sometimes done. This can only hinder the development and proper territorial organization of the country's productive forces.

The Congress of the Geographical Society of the USSR should condemn the nihilistic tendencies with regard to the Gosplan definition of an economic region of the 1920's, which still constitutes the basis for the Soviet theory of economic regionalization. From the point of view of the Marxist theory of economic regionalization worked out in the 1920's, it must be clearly stated that the 13-region breakdown of the country in no way represents an economic regionalization of productive forces.

That breakdown contradicts the basic principles of the theory of economic regionalization. The 13-region breakdown in most cases (the South, the Center, Western Siberia, Eastern Siberia, Kazakhstan-Central Asia, and so forth) attributes to huge territories specializations that do not in fact

Basic Economic Regions of the USSR in 1940's

1 - Northwest
2 - North
3 - Center
4 - Volga
5 - North Caucasus
6 - Urals
7 - West Siberia
8 - East Siberia
9 - Far East
10 - West
11 - South
12 - Transcaucasia
13 - Central Asia - Kazakhstan

exist; instead the actual specialization becomes "dissolved" and as a result the given territory loses its economic personality. Once that happens the economic objectives and problems each territory is called upon to solve cannot be formulated with sufficient clarity. It is wrong to represent the 13-region breakdown as the further creative development of the principles of the Gosplan of the 1920's, as P. M. Alampiyev tries to do in his book Ekonomicheskoye rayonirovaniye SSSR (Moscow, 1959, p. 179).

Proposals have been made recently for dividing the country into nine, seven, five or even three basic regions. These proposals reflect attempts to divide the country into major consumption regions, i.e., attempts to carry out a regionalization not on the basis of the production process but on the basis of the marketing process. Such proposals sidetrack the problem of regionalization of productive forces as the basis for their proper territorial organization.

The Marxist theory of regionalization affirms the objective existence of regions, including regions of productive forces. The entire history of the development of productive forces and of their territorial complexes and the history of the territorial division of labor among these complexes show that the number of objectively existing regions of productive forces has been increasing, not decreasing, as the productive forces and their complexes become more complicated and as the territorial division of labor widens and deepens in scope. And the number of economic regions -- the complexes of productive forces having a national production specialization -- has been increasing since the 1920's. A reduction in the number of regions would in fact have meant a lowering of the degree of specialization and of the intensity of the territorial division of labor within the Soviet Union.

The Gosplan line of economic regionalization of productive forces, begun in the 1920's was later (in the 1930's and 1940's and early 1950's) continued by N. N Kolosovskiy, who thoroughly studied the objective process of formation of territorial-production complexes (economic regions), traced the further development of the regions that had been delimited originally by the Gosplan and detected the birth and growth of new economic regions.

On the basis of the scientific contributions made by the Gosplan of the 1920's and by N. N. Kolosovskiy and on the basis of the large amount of available data on the development of productive forces, the Department of Economic Geography of the USSR at Moscow University has proposed a draft general economic regionalization of the USSR with 29 (or 28) basic economic regions or regional complexes of productive forces (see Map on Page 55):

In the RSFSR:

1. Central Industrial Region (Moscow, Kalinin, Smolensk, Kaluga, Bryansk, Tula, Ryazan', Yaroslavl', Vladimir, Ivanovo and Kostroma oblasts).

Basic Economic Regions Proposed by Department of Economic Geography of USSR at Moscow University

2. Central Chernozem Region (Orel, Kursk, Belgorod, Lipetsk, Tambov, and Voronezh oblasts).

3. Northwest Region (Leningrad, Pskov, Novgorod and Murmansk oblasts, and Karelian ASSR).

4. Northern Region (Arkangel'sk and Vologda oblasts, and Komi ASSR).

5. Volga-Vyatka Region (Gor'kiy and Kirov oblasts, Udmurt, Mari, Chuvash and Mordvian ASSRs).

6. Middle Volga Region (Ul'yanovsk, Penza, Kuybyshev and Saratov oblasts, and Tatar ASSR).

7. Volga-Don Degion (Stalingrad, Astrakhan' and Rostov oblasts, and Kalmyk ASSR).

8. North Caucasus Region (Stavropol' and Krasnodar krays, Kabardian-Balkar, Chechen-Ingush, North Ossetian and Dagestan ASSRs).

9. Urals Region (Sverdlovsk, Perm', Chelyabinsk and Orenburg oblasts, and Bashkir ASSR).

10. West Siberian Region (Tyumen', Kurgan and Omsk oblasts).

11. Kuznetsk-Altay Region (Novosibirsk, Tomsk and Kemerovo oblasts, and Altay Kray).

12. Central Siberian Region (Krasnoyarsk Kray and Tuva Autonomous Oblast).

13. East Siberian Region (Irkutsk and Chita oblasts, and Buryat ASSR).

14. Yakut Region (Yakut ASSR).

15. Southern Far East Region (Primorskiy and Khabarovsk krays, Amur and Sakhalin oblasts).

16. Northern Far East Region (Magadan and Kamchatka oblasts).

In the Ukraine:

17. Southern Mining and Industrial Region (Khar'kov, Stalino, Dnepropetrovsk and Zaporozh'ye oblasts).

18. Central Ukrainian Region (Kiev, Vinnitsa, Khmel'nitskiy, Zhitomir, Kirovograd, Cherkassy, Poltava, Sumy and Chernigov oblasts).

19. West Ukrainian Region (L'vov, Volyn', Rovno, Ternopol', Stanislav, Chernovtsy and Transcarpathian oblasts).

20. Black Sea Region (Odessa, Kherson, Nikolayev and Crimean oblasts).

21. Moldavian Region (Moldavian SSR). (According to another variant, the Moldavian SSR would be part of the Black Sea Region, making a total of 28 regions.)

In Kazakhstan:

22. Central Kazakhstan Region (Karaganda, Akmolinsk, Pavlodar, Kustanay, North Kazakhstan and Kokchetav oblasts).

23. West Kazakhstan Region (Aktyubinsk, West Kazakhstan and Gur'yev oblasts).

24. East Kazakhstan Region (Semipalatinsk and East Kazakhstan oblasts).

25. South Kazakhstan Region (Alma-Ata, Dzhambul, South Kazakhstan and Kzyl-Orda oblasts).

26. Central Asian Region (Kirghiz, Tadzhik, Turkmen and Uzbek SSRs).
27. Transcaucasian Region (Azerbaydzhan, Armenian and Georgian SSRs).
28. Baltic Region (Latvian, Lithuanian and Estonian SSRs, and Kaliningrad Oblast of the RSFSR).
29. Belorussian Region (Belorussian SSR).

The regionalization plan proposed by the Department of Economic Geography of the USSR of Moscow University is a working hypothesis that should be tested by detailed study of the territorial complexes of productive forces and by the formulation of the long-term economic plan.

We must further deepen the methods used for economic regionalization. An economic region should be regarded, first, from the viewpoint of national economic objectives and, second, from the viewpoint of the structure of the productive forces of the region itself. For a solution of the second problem we must work out a theory of development of the territorial-production complex and accumulate data on the specific complexes of the Soviet Union. Thus far studies on the theory of complexes have been limited essentially to the work done by N. N Kolosovskiy.

According to N. N. Kolosovskiy, "a productive complex is an economic (interconnected) combination of enterprises in a given industrial center or in an entire region that achieves a desired economic effect through the proper (planned) selection of enterprises in accordance with the natural and economic conditions of the region and its economic-geographic and transport location" (N. N. Kolosovskiy, Osnovy ekonomicheskogo rayonirovaniya (Principles of Economic Regionalization), Moscow, 1958, p. 138). Thus far this is the only attempt to arrive at a definition of the production complex. This definition is correct but too general. It must be made more specific. The point is that we still do not know how to measure the economic effectiveness of a combination of productive forces, including a combination of enterprises (as opposed to a single enterprise). Scientific thought should concern itself intensively with the formulation of methods for calculating the economic effectiveness of territorial-production complexes. The solution of that problem would enable us to introduce more widely into economic regionalization the quantitative method of analysis, without which no science can make progress. This points up the need for developing the econometric approach in economic geography and to apply mathematical methods.

The solution of the problem of calculating the economic effectiveness of a territorial production complex would enable us to provide a firmer foundation for proving the objective existence of economic regions.

The objective existence of economic regions is proven, in particular, by the fact that a whole string of authors who have tried to regionalize the Soviet Union's productive forces at various stages of development have come up with similar networks of economic regions. But this is only a

supplementary argument for proving the objective existence of the regions. The basic argument is found in the benefit that the economy derives from a general increase of the productivity of social labor under various alternative systems of regionalization. The complex of productive forces of every region must be clearly shown to be the only suitable variant of a territorial organization of productive forces that would achieve the greatest economic effect at the given stage of the country's economic development.

A positive factor from the viewpoint of the Soviet economy was the adoption of a territorial form of management of industry and construction and the formation of the economic councils (sovnarkhozes) of economic-administrative regions. The large number of such councils, now numbering 104, was due to the need for operational management, but it does make difficulties in planning the territorial division of labor within the Soviet Union. Furthermore, most of the regional economic councils manage industry and construction within the relatively narrow framework of the oblasts established in the 1930's and 1940's for the purpose of the operational management of agriculture. In many cases the boundaries of the oblasts (or economic-administrative regions) tend to break up large integral regional complexes of productive forces. Therefore many economic-administrative regions within their present boundaries cannot be regarded as territorial complexes of productive forces having a national specialization. We cannot agree with P. M. Alampiyev when, in his book Ekonomicheskoye rayonirovaniye SSSR (pp. 21, 26, 208-10), he sees in all present economic-administrative regions actually existing territorial-economic units and definite territorial economic complexes and applies to them what is essentially the Gosplan definition of an economic region of the 1920's.

The boundaries of oblasts and the make-up of the economic administrative regions should be reviewed in the near future with a view to insuring not only the operational management of industry and construction to a greater degree than is now possible, but also the complex development of productive forces. A scientifically justified development and territorial organization of productive forces should proceed in groups of economic administrative regions within the boundaries of basic economic regions. The Department of Economic Geography of the USSR at Moscow University has repeatedly urged the establishment of economic conferences of basic economic regions that would include groups of regional economic councils.

Studies on economic regionalization should not be interrupted. The formation of economic regions is a very complex, continuous process; therefore studies on economic regionalization should also proceed without interruption. Otherwise Soviet scholars would not be able to propose a sufficiently justified network of regions when needed and, what is more important, they could not uncover the regional complexes of productive forces actually in existence or in process of development.

We should organize a system of studies in economic regionalization. Many research institutions are now working on economic regionalization.

But this work lacks adequate scope, the necessary theoretical depth and the proper coordination on the part of the Gosplan of the USSR and the Gosplans of the large union republics.

We should make use of the experience acquired in economic regionalization in the 1920's, when a broad program was undertaken on Lenin's orders to clarify the methodology and practical importance of economic regionalization and when not only scientific but also economic personnel were engaged in work on economic regionalization.

The cooperation of local scientific organizations should be enlisted for work on the problem of internal or detailed economic regionalization.

The Department of Economic Geography of the USSR at Moscow University has been working on the economic regionalization problem for many years. Following is a selected bibliography of studies prepared by department staff members in recent years that supplement and amplify the statements contained in the present paper:

N. N. Kolosovskiy, Osnovy ekonomicheskogo rayonirovaniya (Principles of Economic Regionalization), Moscow, 1958.

N. N. Kolosovskiy, "The Region in Soviet Economic Geography," Voprosy geografii, No. 27, 1951.

N. N. Kolosovskiy, "The Scientific Problems of Geography," Voprosy geografii, No. 37, 1955.

N. N. Kolosovskiy, "Problems in the Economic Regionalization of the USSR," Voprosy geografii, No. 47, 1959.

Yu. G. Saushkin and T. M. Kalashnikova, "The Basic Economic Regions of the USSR," Voprosy geografii, No. 47, 1959.

T. M. Kalashnikova, "Some Methodological Problems in the Economic Regionalization of the USSR," Voprosy geografii, No. 47, 1959.

I. I. Belousov, "The Economic Regionalization Plan Proposed by N. N. Kolosovskiy," Voprosy geografii, No. 41, 1957.

Yu. G. Saushkin, "Problems in the Economic-Geographic Regionalization of the USSR," Vestnik Moskovskogo universiteta, seriya biologii, pochvovedeniya, geologii, geografii, 1958, No. 3.

T. A. Solovtsova, "The Volga-Don Basic Economic Region," Voprosy geografii, No. 47, 1959.

Yu. G. Saushkin, T. M. Kalashnikova and V. P. Lebedeva, "Economic Regionalization as a Method of Studying Economic Phenomena," Nauchnyye doklady vysshey shkoly. Geologo-geograficheskiye nauki, 1958, No. 1.

Yu. G. Saushkin, "Comparison of the Networks of Basic Economic and Tectonic Regions of the USSR," Voprosy geografii, No. 47, 1959.

Otechestvennyye ekonomiko-geografy XVIII-XX vekov (Russian Economic Geographers From the 18th to the 20th Century), edited by N. N. Baranskiy, N. P. Nikitin and Yu. G. Saushkin, Moscow, Uchpedgiz, 1957.

Yu. G. Saushkin, Ekonomicheskaya geografiya SSSR, No. 1, Moscow University, 1957.

A. G. Burenstam and P. Ye. Semenov, "Some Economic-Geographic Problems of the Development of Central Kazakhstan Based on the Proceedings of the Karaganda Scientific Session of November, 1958," Geografiya i khozyaystvo, No. 5, 1959.

(Editorial note, S. G. : The foregoing paper presents part of the Moscow University approach to the problem of delimiting basic economic regions for long-term planning purposes. Another view, presented by P. M. Alampiyev of the Economic Research Institute of the Gosplan, appeared in Soviet Geography, April 1960, pp. 43-51. A third view, by A. Vedishchev in Voprosy ekonomiki, February 1960, proposing a system of eleven regions, was translated in Current Digest of the Soviet Press, 1960, No.11. An article dealing with the related problem of the distribution of productive forces by Ya. Feygin, appeared in Voprosy ekonomiki, January 1960, and was translated in the Current Digest of the Soviet Press, 1960, No. 9.

(The basic economic regions, or major economic regions, to be delimited for planning purposes should not be confused with the 104 existing economic administrative regions of the USSR. These regions, coinciding with administrative oblasts in the RSFSR, with groups of oblasts in the Ukrainian, Kazakh and Uzbek SSRs, and with entire republics in the case of the smaller union republics, were set up in 1957 when the management of industry and construction projects was transferred from national government ministries to regional economic councils (sovnarkhozes). The economic administrative region is thus simply an area within which the given regional economic council has jurisdiction over the management of industry and construction. The economic administrative regions were discussed by Paul E. Lydolph in The Professional Geographer, July 1958.

(In addition to delimiting basic economic regions containing groups of oblasts or republics, Soviet geographers are concerned with the determination of economic regions within oblasts or republics. A separate paper of the regionalization symposium is devoted to that problem and will be published in a coming issue of Soviet Geography.)

THE ANGARA PROJECT

(Editorial note, S. G.: The following three articles, translated from the Soviet daily press, are presented as a progress report on the Angara project of hydroelectric stations in Siberia. Although published in the daily press, these articles contain material of interest to geographers. The Angara project thus far includes the Irkutsk station (in full operation), the Bratsk station (under construction; first power expected in 1961) and the Ust'-Ilim station (construction planned).

PROBLEMS OF THE ANGARA SERIES OF HYDROELECTRIC STATIONS

By I. Naymushin, manager of the Bratskgesstroy (building contractor of the Bratsk construction project) and A. Gindin, chief project engineer.

(From Pravda, December 14, 1959)

The Bratsk hydro station is a star of the first magnitude in the constellation of electric power stations being built in the Soviet Union. It would be difficult to exaggerate its importance for the development of the productive forces of Eastern Siberia.

The Bratsk construction project will soon mark its fifth anniversary. In that time a huge amount of construction work has been carried on in once virtually uninhabited area. The completed construction includes 240,000 square meters of housing, 18 schools, children's institutions, movies, clubs and dining halls. Construction work done includes 23 million cubic meters of earth and rock excavation, 767,000 cubic meters of concrete and reinforced concrete work, and 39,000 tons of steel construction. The project has built 377 kilometers of truck roads, 126 kilometers of railroad, 380 kilometers of underground communications, 5,560 kilometers of overhead communication lines and 2,200 kilometers of power-transmission lines.

The project has been well supplied with machinery, including 89 excavators, more than 2,000 trucks (of which 1,200 dumpers), and many cranes, bulldozers and other equipment.

During that period the Bratsk area has acquired a large industrial base for sawmilling and the production of concrete, aggregate and prefabricated concrete and reinforced concrete blocks and shapes.

But the most important development has been the establishment of a large harmonious construction group on the Bratsk project site. The Irkutsk Oblast party organization has carefully nurtured the group. Thousands of Komsomols and hundreds of Communists were commandeered to the site. The history of development of Siberia will never forget the spirit of the boys and girls who cut through the tayga, forced rivers and swamps and in record time laid the 628-kilometer power-transmission line from the Irkutsk hydro station, first in the Angara series, to Bratsk.

More than 6,500 boys and girls were commandeered by the Komsomol to the Bratsk project and more than 2,000 young people arrived after their discharge from the army.

When we began the project we considered the manpower problem the most critical one. The fears were unfounded. As soon as news of the Bratsk project appeared in the press, thousands sent in job applications. Most of the young people were not trained in the construction business and we had to set

up a large training program. More than 11,000 have completed their training period, and 2,000 are now being trained. In addition there are 1,000 students in the schools for working youths and 600 are taking correspondence courses with colleges and technical schools.

At the beginning of 1957 we began to build the cofferdam for the foundations of the Bratsk dam. Now we are laying concrete in the dam and are excavating for the power plant site and for the second section of the dam.

The Bratsk station is one of six in the Angara hydroelectric series. The six stations, with a total installed capacity of 13 to 14 million kilowatts, are expected to generate 70 billion kilowatt-hours of electricity a year, of which almost 22 billion will be furnished by the Bratsk plant.

As a result of party appeals for cheaper and faster construction of hydroelectric stations, the cost estimate of the Bratsk station has been cut by almost 3 billion rubles. This has been achieved by a 33-per-cent reduction in concrete work, which in turn reduced the need for concrete-mixing installations and housing.

Compared with the Kuybyshev dam on the Volga, the cost per installed kilowatt at Bratsk has been cut by 3.5 times in money terms, by 5.4 days in man-days, by 4 times in cement, 3.5 times in construction steel and 2.7 times in timber. In other words, the labor and materials spent on Kuybyshev dam would be sufficient to build three equivalent stations on the Angara. This is to be explained by the fact that the Bratsk workers have heeded the party's appeals and that the Angara River is an ideal stream for hydroelectric construction.

The experience of the Bratsk project shows that costs could be reduced even further and approach the costs of building very large thermal stations. Specifically that could be achieved if the Angara series is viewed and planned as a whole rather than as a series of isolated stations. Huge hydroelectric stations in uninhabited areas should be regarded as parts of large power-oriented production centers to be built simultaneously with the stations themselves.

It should also be remembered that the new power stations in Siberia are being built in the middle of vast forests. As in the case of Bratsk, the construction of each station should be associated with the building of a lumber center to process the wood cut on the reservoir site.

The construction of the hydroelectric station itself costs less than one-third of construction of the production complex. Such a complex must includea single building supply base and must be built by a single building contractor. The establishment of the supply base alone involves large capital investments; in the case of Bratsk, it cost 3 billion rubles.

If work on the Angara series were to be interrupted after completion of

the Bratsk station, the entire building supply base would become superfluous in the few years. In addition the whole Bratsk construction team, with its experience of building huge power dams under East Siberian conditions, would disintegrate. It would be in the national interest, therefore, to organize the construction of the whole Angara series as a continuing project based on the existing Bratsk supply base.

If that is done, there will be no need to build new plants for wood processing or the fabrication of reinforced concrete blocks and shapes or a central truck-repair plant or any number of other service industries. This alone would save 600 to 700 million rubles in the construction of a Ust'-Ilim hydro station with the same installed capacity as Bratsk's (4.5 million kilowatts).

Power-oriented industries should be built in the Ust'-Ilim area simultaneously with the station itself. This would make it possible to build a permanent town for industrial workers instead of temporary settlements for dam builders. The service departments of the future factories could temporarily house the construction organizations building the entire industrial area. This would save an additional 600 million rubles.

The total savings resulting from such an approach and from the gradual transfer of the experienced Bratsk dam builders to the Ust'-Ilim site would be 1.4 billion rubles.

On N. S. Khrushchev's instructions we made a comparative calculation of needed capital investments showing that the construction of an aluminum plant next to the Ust'-Ilim hydro station would cut about 1.5 billion rubles from the combined construction cost. Such an integrated approach to industrial construction would cut the power cost at the Ust'-Ilim site to 0.4 kopeck per kilowatt-hour and would reduce the production cost of a ton of aluminum by 50 per cent compared with the Urals aluminum plants.

Solid masonry gravity dams are the principal structure on the hydro sites of the Angara River. The Bratsk dam, with a height of 127 meters, is the highest in the Soviet Union as of now. To insure a high stability of the dam, we need frost-resistent and watertight concrete for the outer zones of the dam and crack-resistant concrete for the inner zones. The most critical problem is building a crack-proof dam. This requires homogeneous concrete, careful temperature control during curing, careful selection and high quality of the aggregate and the use of the least amount of cement per cubic meter of concrete.

Each year we in the Soviet Union pour dozens of millions of cubic meters of concrete. But unfortunately we still do not have a real concrete-mixing industry that would have standard procedures for making concrete with the least amount of water and cement at temperatures of not more than 5 to 8 degrees C. Moreover, even if we could obtain such concrete, we have virtually no machinery for laying concrete (bulldozers and vibrators, for example). The Ministry of Power-Station Construction, the State Building Committee

and the State Planning Committee should be seriously concerned with that problem. We need factories and machinery for making a good aggregate and mass concrete with temperature regulation at any time of the year. Construction projects should be supplied with bulldozers for leveling the concrete mix as well as high-frequency vibrators.

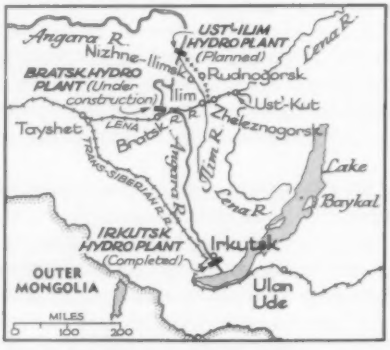
Just as important is the supplying of the Bratsk project with cement of definite specifications. That problem is still not solved. The Bratsk project is getting cement from many factories and much of it is below standard specifications. We are requesting the State Planning Committee of the USSR and the Council of Ministers of the RSFSR to study this matter without delay.

A continuous, integrated construction of the Angara series of hydroelectric stations and their associated industries will create a major area of power-oriented industries in Siberia and help the Soviet Union catch up and surpass the United States in the shortest time and at the least cost in the production of several important industrial commodities.

(From Pravda, February 3, 1960)

The party and the government are giving special attention to the development of the productive forces of Eastern Siberia. In a previous article we discussed some of the problems of the new industrial center at the Bratsk Hydroelectric Station. The next station in the Angara series, the Ust'-Ilim station, is to be located 250 kilometers below the Bratsk station.

Site surveys carried out by the Hydroelectric Designing Institute have uncovered favorable geological conditions for the construction of the Ust'-Ilim station. On the proposed site, as on the site of the Bratsk project, the Angara cuts through hard diabase rock that can supply a good foundation for any kind of dam. The head at the Ust'-Ilim station will be 90 meters compared with 105 meters at Bratsk, but the installed capacity of the Ust'-Ilim station and its expected power production will be the same as at Bratsk in view of the greater discharge of Angara water.



Angara River Project

The construction of a 238-kilometer railroad will be necessary to serve the Ust'-Ilim project and its power-oriented industries. According to the most suitable alignment, the railroad will join the Tayshet-Lena main line at Khrebtovaya Station. The new railroad will pass through the rich Rudnogorsk iron-ore deposit, which will be operated in surface mines and yield ore for use directly in blast furnaces without concentration. The railroad will also pass through large potential lumbering areas, near deposits of pure sands and limestones, suitable as chemical raw materials, and will serve the southern part of the Tunguska coal basin.

There is no time to be lost. The Railroad Construction Ministry should even now start surveying the Khrebtovaya-Ust'-Ilimskaya route. The new railroad will greatly expand the raw-material base for lumber and woodworking and mining industries of the Bratsk area and will make it possible to develop heavy industry further in the eastern part of the country on the basis of the Bratsk and Ust'-Ilim hydroelectric stations. The known raw-material reserves gravitating toward the existing Tayshet-Lena railroad are making it possible during the current seven-year plan to build and place into operation the Bratsk wood-processing complex and the Zheleznogorsk (Korshunikha) iron-ore mine and concentrator. By the end of the seven-year plan the area is expected to produce annually 23 billion kilowatt-hours of electric power, 5.9 million tons of iron-ore concentrate, 280,000 tons of paperboard, more than a million cubic meters of sawnwood and several other wood products as well as pulp.

After completion of the Ust'-Ilim hydro-power complex, the Bratsk area will produce 45 billion kilowatt-hours of electric power a year as well as a large quantity of power-oriented commodities. In addition, a second larger wood-processing center will be set up on the basis of the timber resources adjoining the Ust'-Ilim hydro station. Within the next ten years the Bratsk area will thus become one of the country's new large industrial centers.

Realization of that project will require the moving of 150 million cubic meters of concrete and reinforced concrete and the assembling of 4 million cubic meters of prefabricated reinforced concrete sections. Additional manpower must be attracted to the area and about 1,500,000 square meters of housing must be built for the newcomers.

Comfortable living conditions are being created primarily through mass-production methods in construction and through maximum use of electricity in everyday life. Although it may seem strange in the midst of the Siberian forest, housing is now built more cheaply, better and more rapidly with prefabricated sections for multi-story buildings rather than with wood. The establishment of a plant for the building of prefabricated houses is therefore of the highest priority. Such a plant, with a capacity of 125,000 square meters a year, is now being erected in Bratsk. It is scheduled to start production next year. At the same time facilities are being expanded for the production of prefabricated reinforced-concrete sections and wall materials. In 1962 the Bratsk area is expected to produce 400,000 cubic meters of

prefabricated sections, 140,000 cubic meters of fiberboard, 90,000 cubic meters of porous concretes and 70,000 cubic meters of keramzit concretes (keramzit is a porous clay filler).

Equally important are steps to insure a supply of vegetables, potatoes and fresh milk for the local population. With proper management these products can be produced locally. Even corn is being grown in the Bratsk area for use as silage for dairy cattle. Past experience at the Bratsk State Farm, established in 1959, shows that all local inhabitants could be supplied with fresh milk, vegetables and potatoes starting this year.

The construction of a high-yeast feed factory based on by-products of the woodworking industry would eliminate the present shortage of albumins for livestock and poultry. A meat-packing plant and a dairy plant are being built in Bratsk. A poultry factory is in operation since 1959.

The Ministry of Agriculture of the RSFSR should even now concern itself with the organization of state farms in the areas of the construction sites of the Zheleznogorsk iron-ore concentrator and the Ust'-Ilim hydroelectric station.

For our remote area it would be a great thing to have television relay stations at Bratsk, Zheleznogorsk and Ust'-Ilimsk as well as a relay line from Irkutsk to Bratsk. We are requesting the Ministry of Communications to include these projects in its plan for 1960-61. It would make possible better living conditions in accordance with N. S. Khrushchev's instructions.

The construction workers of the Bratsk area still need more modern equipment. In general hydroelectric construction sites, and ours in particular, are well equipped with machines, but some types of work are still poorly mechanized, and that applies to the blasting of hard rock. Some of the drills sent to us are not working well under local conditions. As a result drilling and blasting work is not able to keep up with the excavators. Matters are even worse with rock work at the base of the dam. Blasting is not permitted there and the work must be done by hand. Scientific research institutes should help us solve that problem.

We still have not solved the problem of excavating in frozen ground. This problem is especially important in our area, where the ground is frozen eight months of the year up to a depth of four meters. We have no reliable modern machine for excavating frozen ground.

The existing disproportion between the sizes of the excavator shovels and of the truck bodies has become intolerable. The Bratsk construction workers are equipped with fine 4-cubic-meter shovels. Hauling for these shovels would require at least 10-ton trucks. Actually our truck pool consists mainly of 5-ton dump bodies. We are requesting the State Planning Committee of the USSR to supply larger dump trucks. It would increase labor productivity in earth-moving work by at least 50 per cent.

In accordance with party and government decisions we are increasing use of prefabricated concrete sections in hydroelectric construction, especially in heavyweight work. Concrete facing blocks weighing up to 7.5 tons have been especially effective at the Bratsk project. But if these blocks are to be produced economically, we must create standard designs for movable concrete yards and machines mass-producing prefabricated heavyweight sections for dam sites, especially concrete facing blocks.

Another important problem is the proper organization of the project management. We now have three chief engineers: one for the construction project, one for the management of the hydroelectric station, and one for the designing organization. This situation renders agreement on many questions extremely difficult. Questions that could be settled by the chief construction engineer in a few minutes require months of discussions and frequent trips to Moscow.

The station management does not concern itself with checking the construction plans or with ordering and accepting equipment or with technical control and inspection. All these functions are handled by the building contractor. All the management is doing is to pay for construction work completed, a function that is already virtually handled by the Construction Bank, which inspects the completed work almost every quarter.

The management is nevertheless charged with the financing of the establishment of the construction base and of the hydroelectric station itself, to issue orders for equipment, and to receive and issue the construction plans. It is also charged with concluding agreements for research work relating to the construction project, while the building contractor, who is responsible for the time, quality and cost of the construction work, is virtually unable to influence these factors.

The transfer of the construction of the hydro station to a single management, that is, the transfer to the building contractor of the whole range of rights, and not only responsibilities, would greatly increase the operational efficiency and technical quality of construction, at the same time reducing the number of duplicatory technical and engineering personnel on the construction site.

Questions of the relationship between the building contractor and the designing organization also must be fully settled. The isolation of the designing organization from the building contractor is aggravated by the great physical distance separating the organization from the construction site. For example, the general designing organization for the Bratsk hydroelectric station -- Gidroenergoproyekt (the Soviet hydroelectric station designing organization)-- is in Moscow, and many other designing agencies are in Leningrad, Kiev and other cities.

The designing organization takes orders from neither the so-called customer (the station management) or the building contractor and works out

virtually all construction plans and estimates as it sees fit not only for the basic structures, but even for the construction supply bases and machinery. The customer approves these plans and estimates, often without consulting the building contractor. Such a situation cannot but lead to delays in construction. The construction of the hydroelectric station and its associated industrial complex should be handled by a permanent regional construction organization placed directly under the Ministry of Power-Station Construction and vested with full rights in the financing of the project and the ordering of the construction plans and estimates. The functions of the station management should be restricted to preparations for operation of the completed hydro station. It would also be a good idea to set up a large working group of the designing organization directly on the project site and to place it under the jurisdiction of the building contractor.

The creation of the Angara series of hydroelectric stations and associated industrial areas is a complex national economic objective, whose solution should attract the best people of the country as well as the attention of the Academy of Sciences of the USSR and the Academy of Construction and Architecture of the USSR.

MUST THE ILIM VALLEY BE FLOODED?

(From Izvestiya, February 17, 1960)

It was with profound satisfaction that Siberians heard the news that it had been decided to renew the site survey and the planning of the Ust'-Ilim hydroelectric station, the third of the Angara River series.

Problems of development of the hydro-resources of the Angara River are of great interest to the public of Eastern Siberia because the construction of large hydroelectric stations on the river will radically change the economy of the region west of Lake Baykal.

The construction of the first two Angara stations has resulted in considerable losses to the national economy. The Irkutsk hydroelectric station, for example, was built without shipping locks and the construction of the Bratsk station required the relocation of a large section of the Lena Railroad, which had been completed only recently.

The site selection of the new Ust'-Ilim station and its proposed construction plans have been discussed only in electric power circles of Eastern Siberia. It is not too late to correct that oversight and to submit the construction plans for discussion by the public at large, especially because there are many persons in Irkutsk Oblast, and especially in the Nizhne-Ilimsk Rayon, who do not agree with the selection of the station site at Tolstyy Mys.

The question of the site selection has a rather long history. As early

as the 1930's, such hydroelectric experts as Academician I. G. Aleksandrov, Professsor V. M. Malyshev and Professor N. N. Kolosovskiy, after long study of the hydro-resources of Eastern Siberia, proposed the construction of a large hydroelectric station above the mouth of the Ilim River as part of the Angara series. Six alternatives of using that section of the river were worked out in 1953, of which three called for construction of the dam below the mouth of the Ilim and three above the mouth.

All six alternatives were nearly identical in installed and guaranteed generating capacity, in average annual power production, in construction costs and in the cost of a kilowatt-hour.

Site surveys are now being conducted only at Tolstyy Mys, which is the probable construction site, in spite of the fact that this alternative will result in the flooding of the Ilim valley.

The question arises whether that flooding is really necessary and whether the authors of the construction plan have weighed all the consequences of flooding the Ilim valley over a distance of more than 200 kilometers.

The construction of the station below the mouth of the Ilim will result in the almost complete elimination of agriculture in the Nizhne-Ilimsk Rayon since the reservoir will flood more than 90 per cent of the cultivated land.

The collective farms situated in the valley can of course be moved elsewhere. But the experience of moving farms out of the zone to be flooded by the Bratsk reservoir has already shown that the forest along the shores of the reservoir has few large clearings suitable for agriculture.

The transfer of agriculture to higher elevations is no simple matter. It involves the threat of crop losses because of frosts, not to speak of the fact that the development of forest lands for agriculture is a complicated, expensive and inefficient business.

Agriculture in the Ilim valley, with its 20,000 hectares of farm land, could be preserved in its entirety if the Ust'-Ilim station were built above the mouth of the Ilim.

Such an alternative, moreover, would eliminate the need for expensive work to regulate the flow of the Ilim with its extremely uneven discharge at high and low water. For example, the maximum discharge in May at the village of Sotnikova, 49 kilometers above the mouth, is 2,060 cubic meters a second, and the minimum in February is 20 (L. K. Davydov, Gidrogeografiya SSSR (Hydrogeography of the USSR). Vol. II, p. 417). Furthermore, there would be no need for rebuilding the railroad bridge at Ilim Station.

This alternative would also result in savings of at least 200 million

rubles needed to cut the trees in the planned reservoir zone of the Ilim valley.

It would eliminate the need for resettling the collective farms of the Ilim valley. In fact, some of the money that has been set aside for the clearing of the Ilim valley and for resettling the farms could be used to rebuild and intensify Ilim agriculture to make it a firm food-supply base for the workers of the Ust'-Ilim station, the Zheleznogorsk (Korshunikha) and Rudnogorsk iron mines and the new industries that are expected to rise around the power station.

In short, there are adequate grounds for the planning organizations to renew the Ust'-Ilim station site surveys above the mouth of the Ilim River and for the public at large to subject the various alternatives to general discussion.

(Signed):
M. Odintsov, director of the East Siberian Geological Institute of the Academy of Sciences USSR.
V. Skalon, professor of biology at the Irkutsk Agricultural Institute.
N. Florensov, professor of geology at Irkutsk University.
V. Sherstoboyev, professor of economics at Irkutsk Finance and Economics Institute.
V. Shotskiy, head of the department of economics and geography of the East Siberian Branch of the Academy of Sciences USSR.
G. Vyzgo, senior engineer of the Reservoir Section of the Hydroelectric Designing Institute.
Irkutsk.

ATLAS BELORUSSKOY SOVETSKOY SOTSIALISTICHESKOY RESPUBLIKI (Atlas of the Belorussian SSR), published by the Academy of Sciences of the Belorussian SSR, Minsk, 1958, 18 by 27 cm, XIV plus 140 pages)
Reviewed by O. S. Steblin-Kamenskaya and L. P. Al'tman

(From Vestnik Leningradskogo Universiteta, 1959, No. 24, Pages 159-60)

The atlas was published on the occasion of the 40th anniversary of Soviet Belorussia. It is the first integrated atlas of one of the union republics to be published in the USSR in the post-war period. The atlas is designed for general use. It gives a rather complete and diversified picture of the natural environment, population, economy, culture, history and political-administrative divisions of the republic.

The atlas was compiled by staff members of the Academy of Sciences of the Belorussian SSR, the Academy of Agricultural Sciences of the Belorussian SSR, the State Planning Committee of the Belorussian SSR and the

Main Administration of Geodesy and Cartography of the Ministry of Interior of the USSR. The most recent cartographic, statistical and text materials were used. The atlas contains 140 maps, many diagrams, graphs and tables. Among the maps devoted to the natural environment are physical, geologic, tectonic, minerals, Quarternary deposits, geomorphic, geobotanic, climatic, peat deposits and forest maps. The maps are supplemented with geologic cross sections, cross sections of peat deposits, soil profiles and graphs. A large section of economic maps includes several maps of industry, including two maps giving the distribution of Belorussia's industry in 1913 and at present. Other maps show the distribution of electric power stations, the peat industry, the building-materials industry, machine building and metal fabrication, woodworking and the paper industry, light industry and the food industry. Agricultural maps include the distribution of agricultural production and specialization, the distribution of machine-tractor stations, melioration-machine stations, repair and technical stations, state farms, crops and livestock types. The atlas also contains maps showing the distribution of elementary schools, secondary schools and higher educational institutions, scientific institutions, sanatoria and rest homes.

In addition to maps showing the environment and the economy of the republic as a whole, there are administrative, physical and economic maps of the individual oblasts. The economic oblast maps are of the all-inclusive type, showing industry, agriculture, and transportation, and are more complete than the special-purpose maps of the republic as a whole. The atlas ends with a series of historical maps, including one showing the formation of the territory of the Belorussian SSR. Special-purpose maps are at scales of 1:2,500,000, 1:4,000,000 and 1:5,000,000, and several climatic maps at 1:8,000,000. The scales of the oblast maps are larger: 1:1,000,000 for administrative maps and 1:1,500,000 for physical and economic maps.

However, in addition to its positive features, the atlas has a number of shortcomings. It gives little attention to the integrated mapping of economic phenomena. All republic-wide maps are special-purpose maps that fail to show the objective interrelations among economic sectors and among areas, between industry and its resource base, between agriculture and its resource base. The industrial maps merely show the distribution of industrial centers without giving the resource base of any industry or its productive relationships. In some cases mutually interrelated phenomena are are divided between different maps. For example, Plate 41-42 shows peat deposits, Plate 56-57 the peat industry, Plate 58 peat reserves and Plate 77-78 marshes. It is not clear what aspects of the glass industry were considered appropriate for the map of light industry , the map of the building-materials industry and on the oblast maps.

Another shortcoming is that the atlas is static in character: its maps reflect the present situation and ignore the dynamics of phenomena, except in the case of the map of industry as a whole (1913 and the present), the power-station map (projects in operation and under construction) and the

peat-industry maps (projects in operation and under construction). There should have been maps showing the prospects of industrial development, melioration work and so forth.

Transportation and communications are oddly neglected in the atlas. The same goes for population maps. The density contours selected for the population density map at 1:4,000,000 do not give a complete picture of the population distribution.

Some maps lack necessary explanations. For example, the uses of various size categories for industrial centers are not explained; nor are the criteria of using various map scales (1:4,000,000, 1:5,000,000) for maps with identical load.

However, in spite of these shortcomings, the Atlas of the Belorussian SSR constitutes an interesting and important cartographic publication.

The following articles of geographical interest appeared in recent issues of Problems of Economics, a monthly translation journal (see Page 80):

January 1960:
Power stations and their role in the development of productive forces. I. Krasnov (from Planovoye khozyaystvo, No. 9, 1959).
The foreign trade of the USSR in 1958 (from Vneshnyaya torgovlya, No. 7, 1959).
Soviet technical assistance in the construction of plants abroad. A. Smirnov (from Vneshnyaya torgovlva, No. 9, 1959).
February 1960:
USSR foreign trade indicators (procedures for compiling trade statistics). V. Zoloyev (from Vestnik statistiki, No. 10, 1959).
March 1960:
Railway electrification during the seven-year plan. A. Kuchko (from Planovoye khozyaystvo, No. 10, 1959).

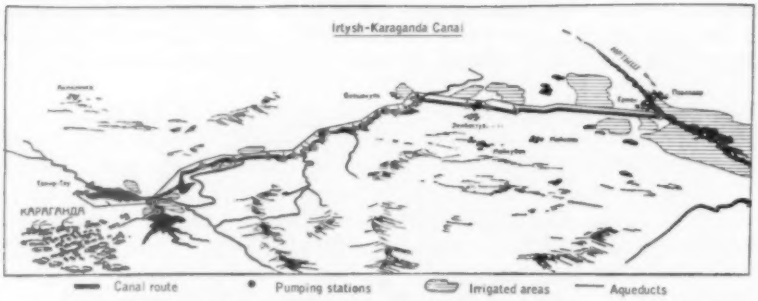
The following articles of geographical interest appeared in recent issues of Current Digest of the Soviet Press:

No. 6, 1960: Ways of raising the economy and culture of the peoples of the North (indigenous Siberian peoples). O. Ivashchenko (from Pravda, February 11, 1960).
No. 15, 1960: The third metallurgical base of the USSR. K. Belyanchikov and P. Shiryayev (from Planovoye khozyaystvo, No. 2, 1960).

NEWS NOTES

By Theodore Shabad

Irtysh-Karaganda Canal. The construction of the Irtysh-Karaganda Canal, designed to supply water to the water-deficient industrial areas of central Kazakhstan, has been approved by the Soviet Government. Preparatory work will begin this year and basic construction is due to start in 1961. The target date for completion of the entire canal is 1965. The canal will start on the Irtysh near Yermak, 20 miles south of Pavlodar, and run 110 miles due west past the coal-mining center of Ekibastuz to the future copper mines of Boshchekul' (Bozshakul'). There the canal will turn southwest, following the Shiderty River upstream to the Karaganda area. The total length of the canal is 320 miles. Twenty-three pumping stations with a total capacity of 342,000 kilowatt will raise the water to an elevation of 1,560 feet at the divide between the headwaters of the Shiderty and the Karaganda area. The canal will have an intake of 75 cubic meters per second (2,625 cubic feet per second); it will be 65 to 130 feet wide at water level, 15 to 30 feet wide at the bottom, and 13 to 20 feet deep. In addition to supplying water to industrial areas, the canal will irrigate 37,000 hectares of cropland supplying vegetables, potatoes and fruit to the urban population.

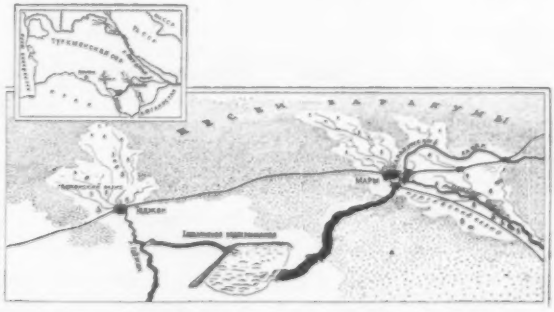


Local Chinese-Soviet Trade. Direct local trade appears to be developing between Chinese and Soviet border areas without going through the usual government-controlled foreign trade channels. A delegation from the Sinkiang Uigur Autonomous Ch'ü of China recently visited the Kazakh and Kirghiz SSRs with a view to establishing direct commercial contacts. Direct exchanges have also taken place in the last three years between China's Heilungkiang Province and the Soviet Union's Amur Oblast. In 1959, trade between these two Amur River areas amounted to $1,425,000 at world prices. In all cases local trade is limited to consumer goods.

New Sevan Lake Project. A 30-year-project calling for the progressive lowering of the level of Lake Sevan in Armenia for hydroelectric and irrigation purposes has been abandoned for a more conservationist approach. The old plan, under which the lake level was to be lowered by 50 meters and the lake area reduced to one-seventh of the natural area

within 50 years, was based on the assumption that the hydroelectric stations on the Razdan River (outlet of Lake Sevan) would be the only sources of Armenian electric power and irrigation. The laying of a natural-gas pipeline from Karadag (near Baku) has sharply changed the fuel-supply situation of Armenia. Moreover, plans are being made for making increased use of rivers and ground waters for irrigation. Under the revised Sevan plan, the lake area will be reduced by only 13 per cent over a 50-year period. Henceforth the Sevan waters will play a regulating role in electric power generation, supplying additional power in periods of peak demand, and will be used for irrigation only in drought years.

Kara-Kum Canal. Additional details have become available on the second section of the Kara-Kum Canal in Turkmenia (Soviet Geography, April 1960, p. 86). The section, extending from the Murgab oasis to the Tedzhen oasis, will be 85 miles long, 100 to 150 feet wide at water level, and deliver 55 cubic meters (1,925 cubic feet) of water per second to the Tedzhen oasis. A storage reservoir at Khauzkhan, with a capacity of 435 million cubic meters (350,000 acre-feet), will store surplus autumn and winter water for summer irrigation. The canal has been declared a mass-participation project and is to be completed within nine months (April-December 1960). In 1961, 27,000 additional hectares are to be irrigated in the Tedzhen oasis. Upon completion of the reservoir in 1962, 45,000 hectares are to be added to the irrigated area.



Caucasus Snow and Ice Conference. The first Transcaucasian conference on the study of the snow cover, avalanches and glaciers of the Caucasus met March 10-14 at Baku. In addition to ice and snow experts of Georgia, Armenia and Azerbaydzhan, the participants included scientists from Moscow, Leningrad, Tashkent, Rostov and Nal'chik. G. A. Avsyuk, head of the department of glaciology of the Institute of Geography of the Academy of Sciences USSR, was among the participants. Forty papers were read. The theme of the conference was the importance of the snow cover and glaciers of the Caucasus for the water supply of Transcaucasia. Among the conference resolutions was one calling for publication of a catalogue of glaciers of the Caucasus.

Caspian Sea Conference. A conference to discuss the drop in the level

of the Caspian Sea opened April 11 in Moscow. Academician D. I. Shcherbakov stressed the importance of that problem for the Soviet economy in view of the Caspian Sea's role in oil production, fisheries, navigation and natural salt deposition. Other participants and their topics were: B. A. Apollov (coordination of Caspian Sea research), N. I. Kozhin (fishery conservation), A. S. Alpeyev (navigation problems), and G. L. Sarukhanov (transfer of water from Pechora-Vychegda basin in northern European Russia to Volga-Caspian basin).

Black Sea Wave Erosion. Wave erosion has become a serious problem on the Black Sea coasts of the Crimea and the Caucasus, which are among the Soviet Union's principal beach-resort areas. A letter to Izvestiya (March 22, 1960), signed by V. Zenkovich, chairman, and A. Zhdanov and A. Aksenov, members of the shore section of the Oceanographic Commission of the Academy of Sciences USSR, notes that the natural erosion process is being speeded by the use of beaches as sand and gravel quarries. The writers say that 400,000 cubic meters of gravel and crushed stone are needed each year for construction and other purposes in the Tuapse-Sochi-Adler section of the Black Sea coast and that nearly all building contractors have been using the beaches as easily accessible quarries. The writers urge the use of alternate sand and gravel sources, such as the beach-gravel accumulations of the Pitsunda, Kodor and Burun-Tabiya headlands, the gravel accumulations in the deeply gouged stream channels and at the mouths of the Shakhe, Mzymta and Psou rivers, and the sand and gravel of ancient marine terraces, such as the Myusser hills of the Caucasus.

Lithuanian Thermal Power Plant. Construction is to begin in 1960 on a 1,200,000-kw gas-fueled power station situated between Vilna and Kaunas. The station, which has been declared one of the priority projects of the seven-year plan, will use natural gas piped from Dashava in the Carpathian foothills. The thermal station project follows completion in April of the 100,000-kw Kaunas hydroelectric station on the Neman River.

Astrakhan' Oil Transshipments. A letter published in Promyshlenno-Ekonomicheskaya Gazeta (February 14, 1960) notes that there is no longer any need for the costly transshipments of crude oil and refined products at Astrakhan', The writers, engineers employed by the Glavneftesnab (oil-products distribution agency), the Ministry of Waterways, and the State Planning Commission of the RSFSR, say that the current practice of transshipping oil products from Caspian Sea tankers to roadstead barges at the "12-foot roads", 100 miles south of Astrakhan', and then from the roadstead barges to riverside oil tanks or Volga River tankers at Astrakhan' costs 2.34 rubles per ton, or more than 20 million rubles during an entire navigation season. The writers call for the construction of tankers that can be used both on the Caspian Sea and the Volga River and will eliminate the transshipments.

Volga-Central Europe Oil Pipeline. Construction has started on a 2,500-mile pipeline carrying crude oil from the Kuybyshev fields of the Soviet Union to Poland, East Germany, Hungary and Czechoslovakia. The northern and southern branches of the pipeline will divide from the basic trunk line at Mozyr' in Belorussia. The northern line will serve refineries at Plock (Poland) and Schwedt (East Germany). The southern line will serve refineries at Szazhalombatta (Hungary) and Bratislava (Czechoslovakia). The East European refineries are expected to receive their first crude oil via the pipeline in 1962-63.

Commercial Siberian Oil Well. The first commercial Siberian oil well has been completed in the Mulym'ya valley at the east foot of the Urals, 135 miles east of Ivdel' and 220 miles north of Tyumen'. The well, completed in April 1960, produces about 200 barrels of crude oil a day.

Man-made Fiber Factories. In keeping with the current emphasis on expansion of the chemical industry, the Soviet Union is pressing the construction of man-made fiber factories. A rayon plant using the viscose process began operations at Ryazan' in May 1960. A kapron (Soviet nylon) factory designed to produce tire cord is under construction on the northeast outskirts of Daugavpils (Latvia).

Synthetic Rubber Component. A methyl styrene department began operations in April 1960 at the Ufa synthetic alcohol plant in Bashkiria. The alcohol plant processes waste gases from adjoining oil refineries. Methyl styrene is a major component, together with butadiene, of Soviet general-purpose synthetic rubber. The Ufa plant will supply the new synthetic rubber polymerization plant at Sterlitamak, south of Ufa.

Troitsk Thermal Power Plant. The first 100,000-kw turbine of the 1,500,000-kw thermal power station at Troitsk (Chelyabinsk Oblast) began to generate power in April 1960. The station is fueled with lignite from the near-by Chelyabinsk field and will supply electric power to the iron-ore mines and concentrators of Rudnyy (near Kustanay) and other industrial areas of the Urals.

New Nickel-Cobalt Project. A new nickel-and-cobalt mine is to be developed at Buruktal, 100 miles east of Orsk, near the Kazakhstan border. A 60-mile railroad spur to the prospective mine is under construction from Profintern station, present rail terminus at town of Dombarovskiy.

Gubkin Becomes Oblast City. The iron-mining center of Gubkin (Belgorod Oblast) in the Kursk Magnetic Anomaly has been raised to the status of city under direct oblast jurisdiction. Two mines are in operation near Gubkin. The Yuzhno-Korobki mine, opened in the spring of 1959, mines iron quartzite underground and enriches the ore in a concentrator. The capacity of the mine is more than 2 million tons of ore a year. The Lebedi surface mine, opened at the end of 1959, produces high-grade iron ore (54 to 57% iron) requiring no concentration. The capacity of the mine is expected to reach 3 million tons a year by the end of 1960. Ultimate capacity is planned at 6 million tons. The Gubkin mines supply high-grade iron ore or concentrate to blast furnaces at Lipetsk and Tula. A third mining center at Mikhaylovka, 60 miles northwest of Kursk, is scheduled to begin operations later in 1960.

Paotow Steel Plant Opens. The first open-hearth furnace at Paotow (Inner Mongolia), with a capacity of 500 tons per heat, opened early in May. A blast furnace, with a capacity of 900,000 tons of pig iron a year, has been in operation since last year. Paotow is designed as one of the three great iron and steel centers of China, the two others being Anshan and Wuhan.

Outer Mongolia's Foreign Trade. In 1959 the foreign trade of the Mongolian People's Republic (Outer Mongolia) was distributed as follows among its trade partners: USSR 77.6 per cent, Czechoslovakia 6.1 per cent, East Germany 4.9 per cent, China 4.8 per cent, Poland 2.6 per cent, Hungary 1.6 per cent, others 2.4 per cent. The principal export categories (in terms of value) were: wool 40 per cent of total exports, livestock 36 per cent, hides 7 per cent, furs 3.6 per cent. Other exports included meat, tungsten and rock crystal. Feed grains were exported for the first time in 1959 to the USSR, Bulgaria and North Korea. Mongolia's imports are primarily manufactured goods.

Kola Iron Ore Expansion. The iron-concentrator at Olenegorsk in the Kola Peninsula has opened a fourth section with an annual capacity of 600,000 tons of iron concentrate, raising the total capacity to more than 2 million tons. Olenegorsk is the iron-concentrate supplier of the Cherepovets iron and steel plant of northern European Russia.

CURRENT LITERATURE

New Geographical Bimonthly of Moscow University. Starting in 1960 the Vestnik Moskovskogo Universiteta, the scientific journal of Moscow University, will appear in several parallel series devoted to individual sciences, of which Series V will cover geography. Soviet geographers thus acquire a new geographic periodical, to be published once every two months. Each issue is expected to devote one or two major articles to geographic problems; it will also contain scientific notes and reports, a geographic chronicle of events in the Soviet Union and abroad, and a bibliography of current literature. Because of lack of space, the new magazine will not include English abstracts of articles, but it will print an English table of contents. These tables of contents will be printed in SOVIET GEOGRAPHY upon receipt of the magazine, and selected articles of interest to American geographers will be translated. In contrast to Geografiya i Khozyaystvo, a Moscow University serial devoted to geography's contribution to the national economy, the new journal will emphasize articles on Soviet geographic thought, research methods and problems of geographic education.

Vestnik Moskovskogo Universiteta, Seriya V: Geografiya No. 1, 1960

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Bulletin of Material on the Geography of the USSR (Department of Geography, University of Nottingham, England).

The first six issues of the useful mimeographed serial were listed in Soviet Geography (April 1960, pp. 87-88). No. 7 (February 1960) of the Bulletin contains selected data from the Soviet statistical yearbook for 1958 covering agriculture, industry and transportation.

The magazine Technical Translations, issued twice a month by the Office of Technical Services, Department of Commerce, is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for $12 a year. The magazine lists translated technical literature available to the public. Beginning with the present issue SOVIET GEOGRAPHY will list translations classified in Technical Translations under "Geography." Unless otherwise stated, translations can be obtained from the Office of Technical Services.

Kuznetsov, N. T., and Hu Tsung-p'ei, Hydrological Conditions in Southwest Dzungaria. Order No. 59-31033. Price $ .50.

Murzayev, E. M. Geographical Observations in Dzungaria. Order No. 59-31032. Price: $ .50.

Kuo Ching-hui. Hydrography of the Rivers in Communist China. Order No. 60-11076. Price: $1.

Li Chen-ch'uan. Economic Geography of the Yen-pien Korean Autonomous Chou. Order No. 60-11045. Price: $2.75.

The following Soviet journals of interest to geographers are available in the form of English abstracts from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

Izvestiya Akademii Nauk SSSR, Seriya Geograficheskaya, journal of the Institute of Geography of the Academy of Sciences USSR. Order No. PB 141 004T. $3.50 a year (6 issues), $ .60 per copy.

Meteorologiya i Gidrologiya. Order No. PB 141 045T. $8.00 a year (12) issues), $ .70 per copy.

Geodeziya i Kartografiya. Order No. PB 141 001T. $7.00 a year (12 issues), $ .60 per copy.

Gidrotekhnika i Melioratsiya (Hydraulic Engineering and Soil Improvement). Order No. PB 141 092T. $6.00 a year (12 issues), $ .50 per copy.

Metallurg (Metallurgist). Order No. PB 141 132T. $7.00 a year (12 issues), $ .60 per copy.

Stal' (Steel). Order No. PB 141 136T. $8.00 a year (12 issues) $ .70 per copy.

Tsvetnyye Metally (Nonferrous Metals). Order No. PB 141 139T. $7.00 a year (12 issues), $ .60 per copy.

The American Institute of Biological Sciences, 2000 P Street, N. W., Washington 6, D. C., publishes a cover-to-cover translation of the Soviet monthly soil-science journal Pochvovedeniye. The translations began with January 1958. Annual subscriptions are $20.00 to university and non-profit libraries, and $40.00 to individuals and industrial libraries.

The International Arts and Sciences Press, 156 Fifth Avenue, New York 10, New York, publishes Problems of Economics, a monthly journal of selected articles published in Soviet economic journals and newspapers. The annual subscription is $50.00. (Recent articles of geographical interest are listed on Page 72.)